CSD Technical Reference Manual

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This manual contains the specifications for proper installation of weatherization measures and correct application of policies for CSD's Weatherization Program through:

- Measure-specific policies and feasibility criteria
- Installation standards
- Quality control metrics
- Diagnostic and energy audit protocols
- Description of assessor, installer, and inspector roles

This manual shall be applied to CSD's LIHEAP, DOE, and ECIP EHCS programs *only*. Other CSD programs shall be guided by separate manuals.

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Technical Reference Manual

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Technical Reference Manual Version Control

Version	Published	Effective	Change Description
1.0	11/2/2020	2/1/2021	Implementation of new CSD Technical Reference Manual which replaces current CSD Field Guide and Weatherization Installation Standards (WIS).
1.1	6/1/2022	7/1/2022	Update of language throughout the manual to clarify policy. Incorporation of DOE policies pursuant to WPN 22-4 and WPN 22-7.
1.2	10/15/2022	11/1/2022	Addition of new LIHEAP standards.
1.3	5/30/2023	7/1/2023	Update of DOE policy content. Addition of content about Audit and Priority List paths. Incorporation of Title 24 updates.

Technical Reference Manual

Table of Contents

1. General Installation Guidelines

Table of Contents

General Installation Guidelines

1. OVERVIEW OF THE TECHNICAL REFERENCE MANUAL

1.1 The CSD Technical Reference Manual (TRM) is a compilation of CSD policies, applicable California codes, and accepted industry practices for weatherization. The manual is comprised of 41 measures and eight appendices.

1.2 The TRM is applicable to the Low-Income Home Energy Assistance Program (LIHEAP) and Department of Energy (DOE) Weatherization Assistance Program (WAP).

1.2.1 At CSD's discretion, the TRM may also be applied to other energy programs under its administration.

1.3 The TRM measure sections are organized based on the following structure:

1. Measure Objectives

   A description of the program goal for the installation of the measure.

2. Install This Measure When:

   Minimum feasibility requirements necessary to install and/or repair the measure.

3. Do Not Install This Measure When:

   Conditions that, when identified, make the measure unfeasible for installation and/or repair.

4. Installation Guidelines

   4.1 General Requirements

   CSD policies that apply to conventional home installation. When different/ additional policies apply for mobile home, multi-family, or DOE jobs, they will be described in sections 5, 6, or 7.

   4.2 Repair or Installation Procedure

   Required procedures for installing or repairing the measure. When different/ additional procedures apply for mobile home, multi-family, or DOE jobs, they will be described in sections 5, 6, or 7.

5. Mobile Home–Specific

   When mobile home installation guidelines differ from those for conventional homes, the policies/installation requirements are provided in this section.

6. Multi-Family–Specific

   When multi-family installation guidelines differ from those for conventional homes, the policies/installation requirements are provided in this section. The Appendix F Multi-Family Standards apply to multi-family whole building projects.

7. DOE-Specific

   When DOE policies differ from CSD installation guidelines, the policies/requirements are provided in this section, including references to DOE Standard Work Specifications.

8. Post-Installation Guidelines

   Required guidelines to ensure that the measure was installed correctly, information and education to give to the client about the measure and proper maintenance, and any unique clean-up and disposal requirements.

9. Material Specifications

   Specific effective useful life values and material specifications for the installed measure.

10. Warranty

    Minimum warranty for the installed measure and materials.

2. TRM APPENDICES

2.1 The program policies and technical protocols provided in the TRM appendices are incorporated by reference into the measure-specific TRM sections. Unless otherwise stated within the individual appendix, these appendices apply to LIHEAP and the DOE WAP.

2.2 The TRM appendices are:

2.2.1 Appendix A Combustion Appliance Safety Protocol

2.2.1(a) This section contains the policies and procedures for conducting combustion appliance safety (CAS) testing of natural gas, propane, fuel oil, and kerosene appliances and the visual inspection requirements for solid fuel-burning appliances.

2.2.2 Appendix B Duct Leakage Testing Protocol

2.2.2(a) This section contains the testing policies and procedures for pressurized duct leakage testing, identification of system leaks, and specification of sealing activities.

2.2.3 Appendix C Shell Leakage Testing Protocol

2.2.3(a) This section contains the testing policy and procedures for depressurization shell leakage testing, identification of shell leaks, and identification sealing activities.

2.2.4 Appendix D Energy Audit/Priority List Protocol

2.2.4(a) This section contains policies for energy conservation measures (ECMs), procedures for conducting energy audits, and procedures for applying priority list measures.

2.2.5 Appendix E Health and Safety Requirements

2.2.5(a) This section contains CSD's health and safety requirements for all agencies, subcontractors, and field personnel. Topics include, but are not limited to, personal protective equipment (PPE), identification of environmental hazards, the deferral policy, the asbestos policy, lead-safe weatherization guidelines, and agency compliance with regulatory agencies.

2.2.6 Appendix F Multi-Family Standards

2.2.6(a) This section contains the installation guidelines for all multi-family whole building projects (applicable when the building contains five or more units with common heating and/or cooling systems).

2.2.6(b) When a measure is not addressed by this appendix, the conventional home standard shall apply.

2.2.7 Appendix G Assessor, Crew Leader, Installer, and Inspector Guide

2.2.7(a) This section contains the job role-–specific policies that are not addressed in individual measure TRMs and are to be applied by assessors, installers, and inspectors in their weatherization duties.

2.2.8 Appendix H Reference Documents

2.2.8(a) Abbreviations and Acronyms

2.2.8(b) Terms and Definitions

2.2.8(c) California Energy Commission Climate Zones

3. GENERAL GUIDELINES

3.1 The information contained in this General Installation Guidelines section shall apply to measure installations. These requirements are included here to prevent repetition of the information in each TRM that applies to all dwellings.

3.2 Application and enforcement of these requirements shall have the same force and effect as all other installation requirements included in this TRM.

3.3 CSD Quality Assurance

3.3.1 CSD will use its own inspectors or third-party inspectors to review and verify that all weatherization activities (including all assessments, diagnostics, measure installations, and inspections) are completed in compliance with program policy defined in the TRM.

3.3.2 An agency ride-along (designated representative) shall accompany the inspector on any client inspection visits and shall provide transportation and equipment to CSD's inspector.

3.3.3 Corrections shall be made during the inspection visit whenever possible. Any corrections that are not completed by the end of the inspection visit shall require proof of correction identified by the inspector and on the Inspection Correction Transmittal provided at the completion of the inspection visit.

3.3.3(a) All non-hazard fails shall be corrected within 20 working days of written notification.

3.3.3(b) Hazard fails must be mitigated within 18 hours of the finding. Any hazard fails that cannot be corrected within 18 hours will require a Hazard Correction Work Plan.

3.4 Minimum Warranties

3.4.1 Material manufacturer warranty (primary material/appliance) and contractor warranty are specified in each individual measure section.

3.4.2 When a measure fails within the warranty period, or corrections are required as part of a third-party quality assurance inspection visit, corrective work (known as a "call-back") is required. Call-back conditions are defined in Appendix G Assessor, Crew Leader, Installer, and Inspector Guide.

3.5 Documentation Requirements

3.5.1 All project documentation shall be maintained in the individual client files. Files may be maintained electronically or in hard copy.

3.5.2 Required client file documentation, when applicable, shall include but is not limited to:

3.5.2(a) Eligibility documentation

3.5.2(b) Permit application and finalized permit

3.5.2(c) Applicable field forms

3.5.2(d) Photo documentation (as defined in Appendix G Assessor, Crew Leader, Installer, and Inspector Guide)

3.5.2(e) Energy audit reports

3.5.2(f) Home energy rating system (HERS) verification

3.5.2(g) Insulation certificate

3.5.2(h) Job invoicing

3.5.2(i) Diagnostics (i.e., CAS, duct leakage, and shell leakage)

3.5.2(j) Leveraging documentation—Measures or upgrades completed with other funding

3.5.3 Job Completion

3.5.3(a) Jobs cannot be billed to CSD until all assessed work is installed, a post-inspection is completed, and all inspection fails have been corrected.

3.5.3(a1) Exception: A dwelling may be considered complete if:

- The entire dwelling was required to be deferred or
- The dwelling received an assessment and/or diagnostics and no other weatherization measures.

3.5.3(b) When a dwelling is served under the Energy Crisis Intervention Program (ECIP) emergency heating and cooling services (EHCS) and will be served under weatherization, the ECIP EHCS work may be closed out separately before weatherization is completed.

3.5.3(c) A job is not considered completed until all permits have been finalized.

3.5.3(d) For dwellings served using DOE funding, inspection of the unit is required to be completed by a certified quality control inspector (QCI).

3.6 Required Weatherization Forms

3.6.1 All forms are standardized for use in CSD's weatherization programs and cannot to be altered. Contractor equivalents may be used in lieu of CSD forms as identified in Table 2-1.

3.6.2 It is required to use the latest published versions of these forms from the CSD Providers' website.

Table 2-1: Required Weatherization Forms

Form #	Form Name	Equivalent Allowed?
51	*SWEATS and PSPS Preparedness Intake*	*No*
52	*Temporary Emergency Portable Appliance Loan Agreement & Waiver*	*No*
57	*ECIP EHCS Assessment*	*No*
320	*Notice of Weatherization/Renovation*	*Yes*
321	*Client Education Confirmation of Receipt*	*Yes*
322	*Record of Tenant Notification Procedures*	*Yes*
515A	*Energy Service Agreement for Occupant*	*Yes*
515B	*Energy Service Agreement for Property Owner*	*Yes*
540	*CSD Dwelling Assessment Form*	*Yes*
540A	*Wx Mold/Moisture Assessment and Release Form*	*Yes*
540C	*Whole-Dwelling Ventilation Calculation Worksheet*	*No*
540D	*Mechanical Ventilation Assessment Form*	*No*
540E	*Single-Family Refrigerator SIR Calculation Worksheet*	*No*
542	*Weatherization Deferral Form*	*No*
543	*Notice of Survey by Electrical Contractor*	*No*
544	*Energy Audit Input Form*	*No*
610	*Insulation Certificate*	*No*
611	*Contractor Post-Weatherization Inspection Report*	*No*
696	*TREAT Multi-Family Energy Audit Bid Request Form*	*No*
700	*Combustion Appliance Safety Inspection Form*	*No*
700B	*CAS Interim Form*	*No*
700C	*CAS Appliance R&R Form*	*No*
704	*Shell Leakage Data Sheet*	*No*
704A	*ACH Calculation Worksheet*	*No*
704B	*RESNET 800 Worksheet*	*No*
706	*Duct Leakage Data Sheet*	*No*
706A	*System Airflow Worksheet (Optional)*	*No*
708	*Lead-Based Paint Regulatory Compliance Report*	*No*
708A	*LSW—RRP Participants Progress Log*	*Yes*
708IS	*LSW—RRP Instructions*	*N/A*
710	*DOE Energy Audit/Priority List Checklist by CZ*	*No*
808	*REM/Design Multi-Family Input Sheet*	*No*
871	*Pre-Weatherization Scope of Work/Sources & Uses Worksheet*	*No*

TABLE 2-1: REQUIRED WEATHERIZATION FORMS

Form #	Form Name	Equivalent Allowed?
872	***Post-Weatherization Scope of Work/Sources & Uses Worksheet***	***No***

4. LICENSING AND CERTIFICATIONS

4.1 Agencies and subcontractors are required to maintain in good standing a Class B General Building Contractor license and/or all required specialty licenses. Contractors shall confirm the applicability and requirements for licensing at https://www.cslb.ca.gov/.

4.2 Specialty licensing is required for specific measures and includes:

4.2.1 C-10 Electrical Contractor

4.2.2 C-20 Warm-Air Heating, Ventilating and Air-Conditioning Contractor

4.2.3 C-36 Plumbing Contractor

4.2.4 C-46 Solar Contractor

4.2.5 C-47 Mobile Home Contractor

4.2.6 D-65 Weatherization and Energy Conservation

4.3 All agencies and subcontractors are required to maintain in good standing Environmental Protection Agency Repair, Renovation, and Painting (EPA RRP) Certified Firm status. A certified firm shall have an appropriate number of EPA-certified renovators to efficiently conduct work to meet EPA requirements for presumed lead-based paint in pre-1978 dwellings.

4.4 All other certifications (e.g., Building Performance Institute [BPI], HERS, etc.) used for qualifying a contractor for the CSD program are to be maintained and in good standing.

4.4.1 CSD requires certain training and certifications for field personnel. Refer to Appendix G Assessor, Crew Leader, Installer, and Inspector Guide.

4.5 Qualified Technicians

4.5.1 Some measures require the installer to have a valid specialty contractor license. Although other licensing may be needed, the following are some of the common licenses that may be required:

4.5.1 (a) C-20 for heating, ventilation, and air conditioning (HVAC) system installations

4.5.1 (b) C-36 for plumbing, including water heater repair/replacements

4.5.1 (c) C-10 for electrical work, including knob-and-tube (K&T) certification and electric panel work

4.5.2 Field personnel who perform CAS diagnostics and repairs are required to successfully complete the CAS course at a CSD-approved training center. Refer to Appendix A Combustion Appliance Safety Protocol.

4.5.3 Field personnel who perform duct or shell leakage diagnostics and sealing are required to successfully complete the Duct and Shell Leakage Diagnostics course at a CSD-approved training center. Refer to Appendix B Duct Leakage Testing Protocol and Appendix C Shell Leakage Testing Protocol.

4.5.4 A specialty credential may be required by the Contractors' State License Board (for other types of work conducted in conventional homes) or from the Department of Housing and Community Development (HCD) (for manufactured housing/mobile homes).

5. FEASIBILITY CRITERIA FOR ALL WORK

5.1 A dwelling must have a minimum 330 sq. ft. of living space to qualify for weatherization.

5.1.1 This minimum size does not apply to multi-family dwelling units.

5.1.2 Travel trailers, boats, and other transportable dwelling types are specifically excluded from the weatherization program.

5.2 All feasible/allowable measures shall be installed.

5.3 No measure shall be installed that:

5.3.1 Violates health and safety requirements as defined in Appendix E Health and Safety Requirements

5.3.2 Is refused by the client (after measure benefits have been explained by the assessor)

5.3.3 Requires installation where unsafe conditions are present, including but not limited to:

5.3.3(a) The presence or possible creation of friable asbestos-containing materials

5.3.3(b) Hazardous insect or animal infestation

5.3.3(c) Hazardous electrical condition

5.3.3(d) Unsafe structural members or condition of the attic/floor (as applicable)

5.3.3(e) Excessive ground moisture in the crawlspace (i.e., standing water, sewage, or mud)

5.3.3(f) Permit-required confined space locations (as defined by California Occupational Safety and Health Administration [Cal/OSHA])

5.3.3(g) Fire hazards and venting obstructions

5.3.3(g1) The client shall be informed of any potential fire hazard.

5.3.3(g2) Minor fire hazards (and venting obstructions) shall be removed/corrected by the contractor per the Limited Home Repair (LHR) Policy.

5.3.4 Using CSD WAP funds for work on condemned properties is prohibited.

5.3.5 In addition, using CSD WAP funds for work on properties where Health and Safety conditions exist that cannot be corrected is prohibited.

5.4 Each measure in the TRM has feasibility and non-feasibility requirements. Refer to “Install This Measure When:” and “Do Not Install This Measure When:” within each measure.

5.5 Mobile Home Combustion Appliances (DOE Only)

5.5.1 Combustion appliances in mobile homes must comply with the Manufactured Home Construction and Safety Standards, which mandates that:

5.5.1(a) All combustion appliances installed by or left in place after weatherization in mobile homes must meet these standards.

5.5.1(b) All fuel-burning appliances in mobile homes except ranges, ovens, illuminating appliances, clothes dryers, solid fuel-burning fireplaces and solid fuel-burning stoves, must be installed to provide for the complete separation of the combustion system from the interior atmosphere of the mobile home (i.e., to draw their combustion air from outside), and be vented to outside the dwelling.

5.5.1(c) Correction of combustion gas venting shall be performed when allowed by program to ensure proper combustion gas venting to outside the dwelling for all combustion appliances, including but not limited to gas dryers and refrigerators, furnaces, vented space heaters, and water heaters.

5.5.1(d) Nonconformance will require correction or removal of the appliance. Note: Correction is only allowed when repair/replacement of the appliance is allowed under the program.

5.5.1(e) If a client will not allow removal of an unsafe combustion appliance (primary or secondary) from the home, deferral is required.

6. PRE-INSTALLATION GUIDELINES

6.1 Worksite Conduct

6.1.1 All staff members are to conduct themselves in a professional manner during all stages of the weatherization process.

6.1.2 Field personnel shall enter the client's residence only when an adult 18 years of age or older is present.

6.1.3 No smoking is allowed at the job site, regardless of position, including all contractor field personnel and supervisors.

6.2 Worksite Safety

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

6.2.2 Weatherization activities shall not adversely affect the health or safety of any occupant per Appendix E Health and Safety Requirements.

6.2.3 Meeting the Cal/OSHA worker safety regulations is the responsibility all parties, including the agency administrator, the contractor, and all field personnel.

6.2.4 All supervising employees and field workers must be aware of conditions in all work areas that can produce injuries. No worker is required to work at a job he/she knows is not safe or healthful.

6.2.5 All field workers' cooperation in detecting hazards and controlling them is required in conformance with Cal/OSHA contractors' internal policies, the Injury and Illness Prevention Plan (IIPP), and other regulating agencies' requirements.

6.3 Deferral Requirements

6.3.1 Conditions may exist that cannot be mitigated because correction exceeds the scope of the weatherization program or cannot be achieved in a cost-effective manner. This may result in full or partial deferral of the dwelling as defined in Appendix E Health and Safety Requirements, Deferral and Referral Policy.

6.3.1(a) Specific conditions requiring deferral are identified in the individual TRM sections and are also included in Appendix A Combustion Appliance Safety Protocol, Appendix B Duct Leakage Testing Protocol, Appendix C Shell Leakage Testing Protocol, and Appendix D Energy Audit/Priority List Protocol.

6.3.2 Where only limited deferral is required, agencies may install feasible measures and shall, as applicable, refer the client to other agencies/programs for additional assistance.

6.3.3 If a condition can be corrected within the program scope, it should be done before additional measures may be installed.

6.3.4 Every effort shall be made to identify deferral conditions before installation work begins.

6.3.4(a) Deferral and safety conditions shall be documented on the CSD 540 Dwelling Assessment form and the CSD 542 Weatherization Deferral form as applicable.

6.4 Client Notification

6.4.1 Notification shall indicate the type of assistance the agency will provide and what the property owner can do to facilitate installation of deferred measures.

6.4.2 Notification shall be provided to the homeowner, or to the occupant and owner/agent when the dwelling is a rental.

6.5 Permits

6.5.1 CSD requires that agencies or their subcontractors obtain a building permit when required by the local jurisdiction, or by HCD for mobile homes.

6.5.1(a) Agencies shall confirm registration with HCD is up-to-date when a permit will be required for a mobile home.

6.5.2 When a permit will be required by the local jurisdiction, CSD requires that the client receive an explanation of the permitting process.

6.5.3 When the dwelling contains obviously unpermitted work (e.g., questionable construction or installation of additions or appliances, etc.), it shall be explained that the building inspector may elect to inspect these additional components and that findings or fines related to this additional examination shall be the responsibility of the property owner.

6.5.4 If the installation of a measure triggers the correction of a preexisting code compliance issue, and is paid for with CSD WAP funds, the specific code requirements with reference to the measure(s) requiring code compliance must be documented in the client file.

6.5.5 Before performing certain weatherization measures (e.g., construction, alteration, specified repairs, replacements, and equipment changes for residential dwellings), the actual weatherization measures requiring a permit shall be determined by the local jurisdiction.

6.5.6 Agencies shall contact CSD prior to weatherization if the local building department has additional (add-on) permit requirements that would fall outside the scope of the weatherization program.

6.5.7 When work is required to be inspected by a building official, the work must remain accessible and exposed for inspection until approved (per the California Building Code).

6.5.8 The actual permit (sometimes called a “job card”) shall remain on site at all times throughout the construction/modification phase.

6.5.9 A copy of the permit application, the receipt for permit costs, and verification of the final permit “sign-off” are required to be kept in the client’s file.

6.5.10 Expired permits must be reported, and a waiver must be sought from CSD before billing this cost. Federal rules do not allow reimbursement for penalties.

7. GENERAL INSTALLATION POLICIES

7.1 Applicable Codes, Standards, and Regulations

7.1.1 Measure installations shall comply with applicable regulations and standards, including:

7.1.1(a) Manufacturer’s instructions and specifications

7.1.1(b) Requirements of the local jurisdiction

7.1.1(c) Title 24 California Energy Code

7.1.1(c1) California Residential Code (CRC)

7.1.1(c2) California Mechanical Code (CMC)

7.1.1(c3) California Electrical Code (CEC)

7.1.1(c4) California Building Code (CBC)

7.1.1(c5) California Plumbing Code (CPC)

7.1.1(d) California State Licensing Board (CSLB)

7.1.1(e) California Code of Regulations (CCR) Title 8 (Cal/OSHA)

7.1.1(f) California Office of Environmental Health Hazard Assessment (OEHHA) Proposition 65

7.1.1(g) Department of Housing and Community Development (HCD)

7.1.1(h) Environmental Protection Agency (EPA)

7.1.1(i) California Department of Public Health (CDPH)

7.1.1(j) U.S. Department of Housing and Urban Development (HUD)

7.1.2 In the event a conflict exists between the above and the CSD standards, the program with the most stringent regulations and standards shall apply.

7.2 Measure installations shall demonstrate quality workmanship.

7.2.1 All measures must be installed in accordance with the current TRM individual measure sections and industry standards.

7.2.2 No measure materials may be left to be installed by the client.

7.2.3 Any damage done to a home during the installation of a measure shall be repaired.

7.3 Material Limitations

7.3.1 All measure materials, repair and replacement appliances, incidental repair parts, and ancillary materials shall comply with the material specifications for the respective measure standards, which are identified in each TRM.

7.3.1(a) If DOE WAP materials are required to be different, the materials will be identified in the "DOE-Specific" section of the TRM.

7.3.2 Only standard material type(s) shall be allowed for each measure.

7.3.2(a) No upgrades shall be allowed to enhance appliances or add decorative items, finishes, colors, etc. unless specified within individual measure TRMs.

7.3.2(b) The client/occupant cannot contribute to the cost in order to upgrade to premium or higher-end materials or to pay for work outside the scope of the program.

7.3.3 On multi-family projects, property owners may be allowed to "buy down" the cost of measure(s) and increase the measure savings-to-investment ratio (SIR). See Appendix D Energy Audit/Priority List Protocol.

7.3.4 Window or door replacements shall not increase the sizing of the replaced item unless required by the local jurisdiction to meet egress requirements.

7.3.5 Installed appliances shall comply with the California Energy Commission (CEC) standards for efficiency, as verified by their inclusion on the CEC's database of certified appliances, an equivalent federal directory, or an approved trade association directory.

8. MEASURE-SPECIFIC POLICIES

8.1. Appliance Repair/Replacement

8.1.1 Gas Appliances

8.1.1(a) Turn off the gas supply at the main valve when:

8.1.1(a1) A gas shut-off valve is installed or replaced

8.1.1(a2) The gas line to the appliance is altered (e.g., moved, extended, etc.)

8.1.1(b) New gas appliance connection

8.1.1(b1) Use a new gas shut-off valve, flexible connector, and adapters. Do not reuse existing gas connection components (Fig. 2-1).

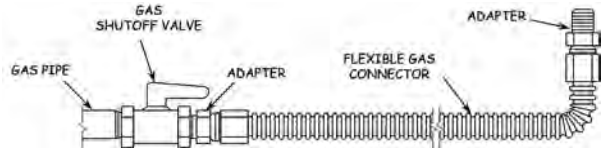


FIG. 2-1: GAS CONNECTION COMPONENTS

8.1.1(c) The gas shut-off valve will be:

8.1.1(c1) Located in the room where the appliance is installed and

8.1.1(c2) Easily accessible to the flexible gas connector

8.1.1(d) Install specified adapters as needed.

8.1.1(e) Do not install flexible gas connectors exceeding 6' in length.

8.1.1(f) Apply gas-compatible sealant (i.e., pipe joint compound or thread seal tape) to all male (external) threads.

8.1.1(g) Tighten connections as instructed.

8.1.2 Gas Line Leak Check

8.1.2(a) Turn all controls and the gas shut-off valve to the off position for the appliance before the main gas supply valve is turned on.

8.1.2(b) With the gas shut-off valve turned on, check all connections and valves for gas leaks by:

8.1.2(b1) Electronic leak detector or

8.1.2(b2) Application of liquid leak detector (wiped off afterward)

8.1.2(c) Correct any leaks before the appliance is placed in its final location.

8.1.2(d) When it is necessary to pressure-test the gas supply system of the residence, isolate the appliance from the gas supply system per the manufacturer's instructions.

8.1.2(e) When the main gas supply valve is turned back on, re-light the pilot lights on all affected gas appliances (Fig. 2-2).

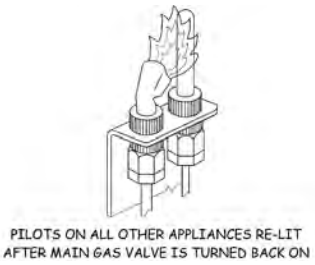


FIG. 2-2: GAS PILOT

8.2. Attic and Crawlspace Accessibility

8.2.1 Working in a Confined Space

8.2.1(a) The Cal/OSHA "confined space" standard may apply to attics, chases, and crawlspaces; therefore, confined space safety practices must be observed. See Appendix E Health and Safety Requirements.

8.2.2 General Accessibility Requirements

8.2.2(a) Attics and crawlspaces must be accessible for assessment, installations, and inspection.

8.2.2(a1) The minimum existing access dimensions for an attic or a crawlspace are 14" x 20".

8.2.2(b) To check for measure installation feasibility:

8.2.2(b1) A sealed access, or an access that is painted shut, must be carefully opened.

8.2.2(b2) An access may be installed, if feasible, when an existing access is not present.

8.2.2(c) Adding or expanding an attic/crawlspace access shall be accomplished under LHR.

8.2.2(c1) Client permission must be obtained when an attic or crawlspace access is installed/enlarged.

8.2.2(d) Repair or replacement of a missing or defective access cover must be completed per Section 32 Infiltration Reduction.

8.2.2(e) If the local jurisdiction is more restrictive for access or clearances, the local policy must be documented and included in the client file or in a centralized file with the agency.

8.2.2(f) When only a limited area in an attic or crawlspace does not meet the clearance requirements, the limitation shall not make all measures in the attic or crawlspace unfeasible.

8.2.3 Attic Accessibility

8.2.3(a) If the only attic access is through a gable vent, the vent must be easily removable or a standard access must be installed.

8.2.3(b) For any installed attic access, the minimum dimensions of the rough-framed opening shall be 22" x 30" or as required by local code. Wood trim shall have mitered corners.

8.2.3(c) Recommended minimum attic clearances:

8.2.3(c1) 24" from the top of the ceiling joists to the bottom of the roof rafters at the highest point

8.2.3(c2) 18" between any obstruction in the attic, such as cross members of truss systems and ductwork

8.2.4 Crawlspace Accessibility

8.2.4(a) When an existing access is sealed, it must be opened to check for measure installation feasibility.

8.2.4(b) For any installed crawlspace access, the minimum dimensions of the rough-framed opening shall be 18" x 24" or as required by local code. Wood trim shall have mitered corners.

8.2.4(c) Recommended minimum crawlspace clearances:

8.2.4(c1) 18" from the ground to the bottom of the floor joist system (girders under a mobile home)

8.2.4(c2) 12" to crawl over or under any obstruction in the crawl area, such as a heating or cooling duct

8.3. Fuel Switching Policy

8.3.1 When fuel switching is considered, the appliance replacement with a different fuel source must be cost-justified by an energy audit in accordance with Appendix D Energy Audit/ Priority List Protocol. The qualifying audit shall be submitted to CSD before the new appliance is installed.

8.3.2 When not fuel switching but installing an alternate appliance type:

8.3.2(a) For heating and/or cooling, refer to Section 4 Heating and Cooling, Change of Heating/ Cooling Type

8.3.2(b) For water heating, refer to Section 13 Water Heaters—Gas, Electric, and Heat Pump

8.3.3 If fuel switching is conducted under LIHEAP and an energy audit will not be conducted, fuel switching requires an approved CSD waiver.

8.3.3(a) An energy audit is required to be conducted to justify fuel switching. Examples of measures that may be installed in conjunction with fuel switching are shown in Table 2-2.

TABLE 2-2: MEASURES THAT MAY BE CONSIDERED FOR FUEL SWITCHING

Existing Heating or Cooling Appliance	Proposed Conversion
Electric wall furnace	Wall furnace, natural gas or propane
Electric forced air furnace (heating only)	Forced air furnace (heating only), natural gas or propane
Natural gas forced air furnace (heating only) or Natural gas split system (heating and cooling)	Central heat pump (heating and cooling)
Natural gas wall furnace or Natural gas wall furnace + window/wall AC	Ductless heat pump mini-split
Propane forced air furnace (heating only) or Propane split system (heating and cooling)	Central heat pump (heating and cooling)
Propane wall furnace or Propane wall furnace + window/wall AC	Ductless heat pump mini-split
Woodstove (heat only) or Wood stove + window/wall AC	Ductless heat pump mini-split
Water heater, natural gas or propane	Heat pump water heater

8.3.3(b) The audit model must include all energy/fuel costs associated with both the existing and proposed appliances.

8.3.3(c) For gas appliances, the gas shut-off valve that will no longer be used shall be capped with a brass cap for flare fittings (not standard iron caps), or the valve shall be removed and the pipe shall be capped with a compatible cap.

8.3.3(d) When a new propane line is installed below grade, a secondary liquid propane (LP) safety detector system (valve, exhaust fan, alarm light) will be installed by a certified professional and a waiver is required.

8.3.3(e) Fuel switching measures can only be installed when the Measure SIR is ≥1.0 and the Dwelling SIR (for the total package of measures to be installed) is also ≥1.0.

8.3.3(f) Fuel cost inputs must be the actual cost as incurred by the client. Each household must produce a copy of a current fuel bill including a list of charges.

8.3.3(g) When an energy audit includes fuel switching, non-energy impact (NEI) fuel cost modifiers shall not be used when inputting fuel rates.

8.4. HERS Requirements

8.4.1 The HERS Program was developed by the California Energy Commission (CEC) to address the home rating, inspection, and compliance components of the CCR, Title 24.

8.4.1(a) HERS verification is necessary when weatherization work falls under the HERS verification and compliance requirements for conventional homes. Because mobile homes are under the jurisdiction of HCD, HERS verifications do not apply.

8.4.1(a1) HVAC system “alterations” that require verification include but are not limited to:

- Installation of a completely new HVAC system
- Replacement of a package unit
- Replacement of an air handler
- Replacement of a condenser unit
- Replacement of an evaporator coil
- Replacement of a heating coil
- Replacement of a furnace heat exchanger
- Adding or replacing more than 25' of ducts in unconditioned space

8.4.1(a2) Duct repair, sealing, and replacements that require HERS verification include when:

- 25' or more of new or complete replacement duct is installed
- New or replacement HVAC ducts, air-handling units, cooling or heating coils, or plenums are located in a garage space
- New kitchen exhausts are installed in conjunction with new duct or fully replaced duct.

8.4.1(b) Check with the local building department to determine if HERS verification will be required.

8.4.1(b1) The local jurisdiction may require HERS verifications beyond the minimum set by the CEC.

8.4.2 CSD requires the following HERS documents when HERS field verification and/or testing is required. Copies of the following documents shall be kept in the client file:

8.4.2(a) The mandatory HERS rating forms completed by the installer and signed and submitted by the agency or subcontractor along with the building permit application

8.4.2(a1) To determine which forms are required, see Appendix A 2019 Residential Compliance Forms on the CEC’s website (https://www.energy.ca.gov/sites/default/files/2020-06/Appendix-A_ComplianceFormsList_ada.pdf).

8.4.2(b) The official invoice and HERS inspection form of the HERS rater for rating services showing the type of rating(s) completed and a breakdown of inspection costs

8.4.2(c) A copy of the building department final inspection showing that the required forms are registered by an approved HERS provider and including copies of those forms where applicable

8.4.3 After the final inspection, the installing contractor shall also provide a copy of the registered energy compliance forms to the homeowner.

8.5. Electrical Guidelines

8.5.1 If a substandard electrical system is suspected during assessment, a qualified technician shall identify potential safety issues to determine if correction is feasible.

8.5.1(a) Clients shall be informed in writing about identified problems and safety concerns and the reasons why services must be deferred, when applicable.

8.5.1(a1) The CSD 542 Weatherization Deferral Form shall be used for notification.

8.5.1(a2) If applicable for an electrical hazard, the client shall be provided information on over-current protection, overloading circuits, and basic electrical safety/risks if conditions warrant.

8.5.1(b) If it is not feasible to fix the identified issue(s), then installation of measures affecting the electrical system requires a limited deferral using the CSD 542 Weatherization Deferral form.

8.5.1(b1) The client shall be advised of any appropriate local, state, or federal agency that may assist in correction of the issue (e.g., local housing and community development department, local health department, local utility company, etc.).

8.5.2 For each measure that will be installed that may impact the dwelling's electrical system, verify that the affected electrical circuit complies—or can be made to comply—with the manufacturer's instructions and local code, including:

8.5.2(a) Adequate circuit capacity (voltage, phase, and amperage)

8.5.2(b) Circuit conductors properly sized for the amp draw of the appliance

8.5.2(c) Overcurrent circuit protection (properly sized circuit breaker)

8.5.2(d) Grounding, if required

8.5.2(e) Correct polarity

8.5.2(f) Undamaged wiring (e.g., no slices, cuts, nicks, or other damage)

8.5.2(g) Connections and splices

8.5.2(h) All exposed wiring (not inside a building cavity) is housed in a listed raceway or conduit

8.5.3 Electrical Circuit Alterations

8.5.3(a) When electrical circuit alterations are required for a measure installation and the alteration cannot be performed within the measure cost maximum, a CSD waiver shall be obtained.

8.5.3(b) All electrical alterations shall be performed by a qualified technician.

8.5.3(b1) Overcurrent protection and conductor size shall meet the manufacturer's specifications and local code.

8.5.3(b2) Adequate current capacity shall be available to avoid nuisance tripping of the breaker/fuse.

8.5.3(c) Splices

8.5.3(c1) Connections and splices shall be contained within a fixture, ballast cover, junction box, etc. and secured with wire nuts or in another approved manner.

8.5.3(c2) Splicing connectors shall be secured with properly sized pressure splicing connectors (e.g., wire nuts).

- Electrical tape may be used only to supplement a properly installed pressure splicing connector, not to secure the connection.
- If the connectors provided with the fixture are unsuitable, the correct size shall be provided.
- Twist-type pressure splicing connectors shall be Underwriters Laboratories (UL)-listed, new, properly sized, the correct type, and for the correct number of conductors.
- Connections of dissimilar metals are allowed only with approved methods.

8.5.3(c3) For splices exposed to moisture:

- Apply antioxidant to the joined wires (or use gel-filled connectors)
- Wrap splicing connectors with electrician's tape
- Install covers on junction boxes
- Protect exterior wiring with liquid-tight conduit or cable, connectors, and junction boxes with covers

8.5.4 Electrical Receptacles

8.5.4(a) A broken or missing outlet cover plate shall be replaced before a measure is installed.

8.5.4(b) Installed appliances shall have their own receptacle when feasible.

8.5.4(c) 120-volt receptacle

8.5.4(c1) When a new grounded receptacle is required by the manufacturer for the installation of an appliance, a permit shall be obtained and finalized when required.

8.5.4(c2) Receptacles shall be installed in a secure, mechanically fastened electrical box.

8.5.4(c3) The receptacle shall be grounded in accordance with the Grounding Guidelines provided in this section (Fig. 2-3).

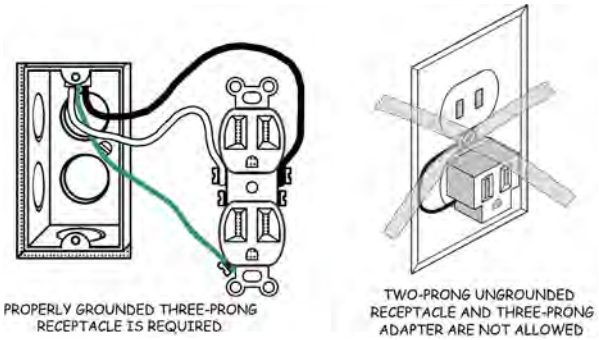


Fig. 2-3: Properly Grounded Three-Prong Receptacle

8.5.4(c4) The receptacle may be oriented upside-down (with the ground slot positioned upward) if the power cord has a right-angle plug with the ground prong positioned at the top (Fig. 2-4).

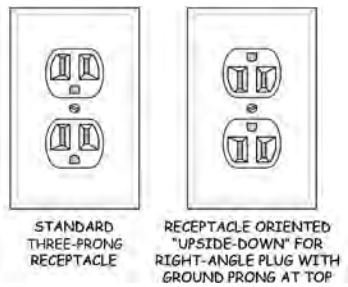


Fig. 2-4: Electric Receptacle Upside Down

8.5.4(d) Ground fault circuit interrupter (GFCI) installation

8.5.4(d1) When a GFCI-protected receptacle will be installed:

- It must be acceptable to the occupants
- It must be easily accessible for resetting
- Occupants shall be advised of the possibility of nuisance tripping
- Occupants shall be instructed in the use and resetting of a GFCI circuit

8.5.4(d2) GFCI protection may not be used for a circuit powering a refrigerator.

8.5.4(d3) Installation of a GFCI unit may be an acceptable alternative for protecting an ungrounded receptacle or switch when installation of a retrofit ground wire is not a good option.

8.5.4(d4) When a GFCI receptacle or GFCI-protected switch is installed where a ground wire is not present, the cover plate shall be labeled "GFCI Protected" and "No Equipment Ground."

8.5.4(d5) Receptacle—For a plug-in appliance (except refrigerator):

- Wires bringing power to the receptacle must be connected to the "line" terminals.
- When present, wires leaving the GFCI receptacle to provide power down-line must be connected to the "load" terminals.
- No wire shall be connected to the ground lug on the GFCI receptacle.

8.5.4(d6) Switch—For a switched fixture:

- A GFCI-protected switch may be connected to an ungrounded two-wire circuit.

- Wires bringing power to the unit must be connected to the “line” terminals.
- When present, wires leaving the unit to provide power down-line must be connected to the “load” terminals.
- No wire shall be connected to the ground lug on the GFCI-protected switch.

8.5.4(e) Three-prong adapters

8.5.4(e1) Three-prong adapters (Fig. 2-5) may be used with appliances only when:

- Manufacturer’s instructions do not prohibit an adapter
- The adapter provides proper polarity and grounding to the appliance with the adapter ground lug/wire securely attached to a grounding source, such as:
  - A grounded receptacle
  - A grounded electrical box
  - An alternate grounding conductor per Grounding Guidelines

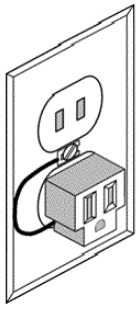


FIG. 2-5: GROUNDED THREE-PRONG ADAPTER

8.5.4(e2) Three-prong adapters may not be used with ranges or refrigerators.

8.6. Grounding Guidelines

8.6.1 General Guidelines

8.6.1(a) Detailed grounding criteria may be found in the CEC, Article 250.

8.6.2 Grounding Electrode Conductor (GEC)

8.6.2(a) A GEC is a wire (typically 6 American Wire Gauge [AWG]) that extends from the service entrance ground rod (or main waterline pipe) to the main service panel grounding terminal bar.

8.6.2(b) Where a GEC is not in place and is required by code for installation of an appliance, one must be installed unless a code-compliant GFCI receptacle can be installed, when allowed by local jurisdiction, per Ground fault circuit interrupter (GFCI) installation.

8.6.2(c) A GEC must meet the following requirements:

8.6.2(c1) Minimum 6 AWG or as required by local code

8.6.2(c2) Properly clamped/bonded to:

- The ground rod and
- The main service panel grounding terminal bar

8.6.2(c3) Any splices in the GEC must be secured with an irreversible compression-type connector or exothermic weld.

8.6.2(c4) The GEC must be protected.

- Where physical damage is not likely, the GEC may be securely fastened to the building.
- Where physical damage is likely, the GEC must be enclosed in a rigid metal or non-metallic conduit or encased in cable armor.

8.6.3 Grounding a Receptacle, Switch, or Metal Box

8.6.3(a) An ungrounded receptacle, switch, or box can be grounded by wiring it to a grounding source (Fig. 2-6):

8.6.3(a1) Option A: When a three-wire grounded receptacle is available elsewhere in the home and can be used, connect it to the ungrounded receptacle/switch.

8.6.3(a2) Option B: When a ground wire can be routed (e.g., in the crawlspace, wall, or attic) without direct exposure to occupants or the outdoors, connect it to the grounding system at the main service panel.

8.6.3(a3) Option C: Run a retrofit GEC from the main service ground rod to the ungrounded receptacle/switch directly or via a junction box.

8.6.3(b) A ground wire exposed in the living space must be in a raceway.

8.6.3(c) A ground wire in the crawlspace or attic does not need a conduit unless required by local code.

8.6.3(c1) Wires that run across the joists must be run either through bored holes in the joists or on running boards.

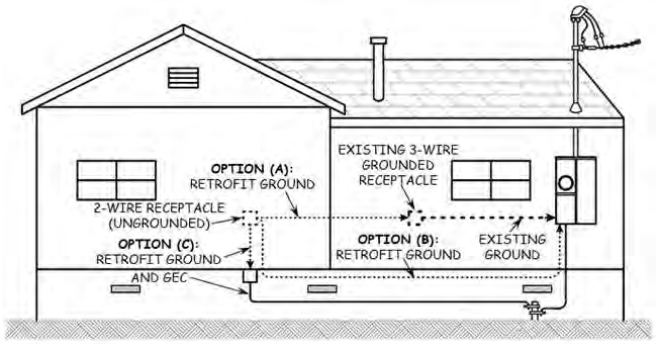


FIG. 2-6: OPTIONS FOR GROUNDING A RECEPTACLE

8.6.3(d) Outdoors, wires must be enclosed in a conduit or cable armor.

8.6.3(e) When a retrofit ground wire is installed, it must meet the following requirements:

8.6.3(e1) Minimum 12 AWG copper conductor for 20-amp circuits

8.6.3(e2) When insulated, colored green or green with one or more yellow stripes

8.6.3(e3) Where exposed, the ground wire must be secured and protected as needed to avoid damage and to safeguard the occupants

8.7. K&T Wiring Guidelines

8.7.1 Feasibility of Measures when K&T Wiring Is Present

8.7.1(a) A safety evaluation shall be required in locations where K&T wiring may be present.

8.7.1(b) Field personnel shall not install insulation in attics or crawlspaces around/near K&T wiring that is energized unless the wiring has been certified safe by an electrical (C-10) contractor through a CSD 543 Notice of Survey by Electrical Contractor certification.

8.7.1(c) Wall insulation shall never be installed when K&T wiring is present in dwelling walls, even when a Notice of Survey is available.

8.7.2 Pre-Installation Requirements

8.7.2(a) Prior to installation of any insulation in the ceiling or crawlspace of a dwelling where K&T wiring is present:

8.7.2(a1) A non-contact testing method will be used to identify live wiring

8.7.2(a2) If work cannot be performed due to K&T accessibility restrictions or unsafe K&T conditions, field personnel must note the existing conditions in the affected areas (i.e., attic, walls, or crawlspace) and provide photo documentation (when possible), to justify the reason the measures cannot be installed in those locations.

8.7.2(b) When an unsafe K&T condition exists, workers are expected to evaluate the feasibility of installing any other measures in the same area without endangering staff or occupants. Installation of measures that may impact the electrical load of the dwelling must be evaluated.

8.7.2(c) C-10 Notice of Survey for installation of insulation

8.7.2(c1) Attics or crawlspaces with K&T wiring shall not be insulated unless the wiring has been surveyed by a licensed electrical contractor (C-10) and certified to be:

- Live and acceptable for encapsulation or
- Abandoned and disconnected

8.7.2(c2) Following the C-10 survey, a Notice of Survey shall be completed.

- When obtained as part of the CSD weatherization programs, the CSD 543 Notice of Survey by Electrical Contractor from the CSD Providers' website shall be used.
- When obtained by a client, the Notice of Survey may have a different appearance, but all components must be present and addressed.

- The survey shall include the C-10 contractor's personal inspection and observation to determine whether all existing K&T wiring in the area is intended to be insulated. The Notice of Survey shall state whether the wiring:
  - Is in good condition with proper overcurrent protection or
  - Is in poor condition (unsafe) but will be brought up to acceptable standards and proper overcurrent protection is present or
  - Is in poor condition (unsafe) and is not suitable to be brought up to acceptable standards

8.7.2 (c3) When required by local jurisdiction, a permit shall be obtained from the local jurisdiction before insulation may be installed.

- When required, a dam that does not cover the top of the K&T will be created to separate insulation from the wire path to protect the occupant and house and ensure future work can be done safely.

8.7.2 (c4) Insulation may cover the K&T wiring as long as a Notice of Survey has been performed, it is allowed by the local jurisdiction, and it is installed in accordance with Section 37 Attic and Ceiling Insulation.

8.7.2 (c5) The following requirements apply to all attics insulated when live K&T wiring is present:

- Insulation shall be non-combustible.
- Barriers, blocking, and supports shall be non-combustible and shall not contain any electrically conductive material.
- When blocking is installed to protect K&T wiring, the wiring must be certified to be safe with proper tamper-proof overcurrent protection, such as a circuit breaker or S-type fuse.

8.7.2 (d) Required K&T notifications

8.7.2 (d1) A completed Notice of Survey must be explained to and signed by the client. A copy must be given to the client after it is signed, and one must be retained in the client file.

8.7.2 (d2) Warning placards stating that caution is required when entering insulated areas because covered electrical wiring is present must be posted in the attic/crawlspace entries where they will be observed by persons entering the area. The warning placards must be printed in both English and Spanish (Fig. 2-7).

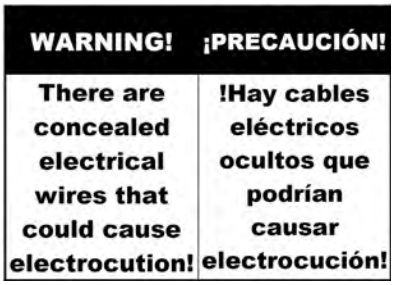


FIG. 2-7: K&T WARNING PLACARD

8.7.2 (d3) The signed Notice of Survey must be posted next to the warning placard at the primary entrance to the work site.

- Additional warning placards and photocopies of the Notice of Survey shall be posted near each openable entrance (accessed from inside or outside the living space) including any openable entrance that is temporarily unused or obstructed by furniture, stored items, etc. but can be opened and used at any time.

8.7.2 (e) Installation of measures in the attic/crawlspace where live K&T is present

8.7.2 (e1) Each installer is responsible for adhering to all requirements of the local jurisdiction regarding insulating over live or abandoned K&T wiring. The local policy must be documented and included in the client file.

8.7.2 (f) Abandoned K&T wiring

8.7.2 (f1) Insulation installation over K&T wiring is feasible when all of the following apply:

- The C-10 contractor certifies that:
  - The K&T wiring is abandoned and not energized, and it is safe to cover it with insulation and

- The wiring cannot be energized by reconnecting abandoned feeder conductors to the service panel or other power source and

- The Notice of Survey form defines the condition

8.7.2 (f2) A copy of the Notice of Survey shall be placed in the client file with the assessment form, and one shall be filed with the local jurisdiction.

8.8. General Insulation Practices

8.8.1 Insulation Certificates

8.8.1 (a) In accordance with Title 24, when ceiling, wall, or floor insulation is installed, completion of the form CSD 610 Insulation Certificate is required and a copy shall be provided to the client.

8.8.1 (b) The certificate shall be completed and signed by the contractor responsible for installing the insulation. The manufacturer, brand, R-value, etc. of the insulation installed in the roof/ceiling, walls, floor, and slab edge must be documented. The installer shall also verify compliance with the applicable mandatory measures (i.e. infiltration and exfiltration) for the building envelope.

8.9. Limited Home Repair (LHR) Policy

8.9.1 In CSD's weatherization programs, for a measure to be installed, feasibility for each measure must be evaluated to ensure that

8.9.1 (a) Occupants' health will not be negatively affected by the installation of the measure and

8.9.1 (b) Conditions in the home are acceptable.

8.9.2 There are instances in which minor/incidental repairs are necessary to facilitate the installation of a measure. The LHR Policy covers these repairs and is subdivided into two categories as defined below.

8.9.3 LHR–Health and Safety (H&S) Support

8.9.3 (a) LHR for H&S-related activities eliminates an H&S hazard that would otherwise prevent weatherization or protects/preserves the installation of an H&S measure. H&S Support does not require cost justification by energy audit and is not included in the SIR calculation for ECMs.

8.9.3 (b) H&S Support may include, but is not limited to, repairs such as:

8.9.3 (b1) Removing minor fire hazards and venting obstructions

8.9.3 (b2) Floor/platform repair for heating/cooling sources or water heaters repaired or replaced under H&S

8.9.3 (b3) Exhaust fan vent extensions (except kitchen exhaust, which is addressed by kitchen exhaust repair)

8.9.3 (b4) Minor electrical system diagnostic or repair to allow the installation of an H&S appliance

8.9.3 (b5) Installation of a broken or missing cover plate

8.9.3 (b6) Domestic clothes dryer moisture exhaust extension to the outdoors to prevent moisture build-up within the living space

- An uninsulated clothes dryer duct must not pass through unconditioned spaces such as attics and crawlspaces, except where allowed by the authority having jurisdiction.
- Condensing dryers must be plumbed to a drain.

8.9.3 (b7) Make-up air for a domestic clothes dryer

8.9.3 (b8) Minor pest removal to allow weatherization

8.9.3 (b9) Repair or installation of an appliance enclosure door that is missing, does not close properly, allows entry of combustion byproducts into the living space, or allows entry of inclement weather into the enclosure

8.9.3 (b10) When repairing or replacing a fireplace damper to support a H&S measure, installation of a spark arrestor per Appendix A Combustion Appliance Safety Protocol

8.9.3(b11) CAS-related repairs to non-conforming appliance venting or gas flex lines in support of proper operation of an H&S appliance per Appendix A Combustion Appliance Safety Protocol

8.9.3(b12) Installation of blocking around heat-producing devices (HPDs) when an attic/ceiling or floor is already insulated to the required level, but no blocking is present

8.9.3(b13) Exposed earthen floors in basements and crawlspaces within the thermal/pressure boundary shall be covered and sealed with a soil gas retarder per Precautionary Measures standard.

8.9.3(b14) Air sealing of sump and well pits within the thermal/pressure boundary through installation of an airtight sump cover per Precautionary Measures standard

8.9.3(b15) In an attic, installation of an IC-rated fixture or installation of an approved cover for a non-IC-rated fixture to eliminate fire danger, when required as a condition of permit by the local jurisdiction per Section 37 Attic and Ceiling Insulation

8.9.3(b16) Other repairs necessary to eliminate an H&S hazard for the protection of occupants and for weatherization work to continue. (Note: This does not include structural repairs or dwelling rehabilitation.)

8.9.4 LHR–ECM Support

8.9.4(a) The majority of measures in CSD's weatherization programs are intended to reduce energy usage. These measures are in a category known as ECMs. ECMs are not H&S measures. When a minor repair is needed to protect or preserve the installation of an ECM, these activities include but are not limited to:

8.9.4(a1) Floor/platform repair for heating/cooling sources or water heaters that are energy efficiency upgrades

8.9.4(a2) Installation of a new attic/crawlspace access, or enlargement of an existing access

8.9.4(a3) When repairing or replacing a fireplace damper for infiltration reduction, installation of a spark arrestor (per Appendix A Combustion Appliance Safety Protocol)

8.9.4(a4) Installation of insulation on an access cover only, when the access cover is uninsulated and the attic/ceiling or crawlspace is otherwise insulated to the required level

8.9.4(a5) Installation of limited screening at a door, window, or other access point to protect against degradation of an installed measure

8.9.4(a6) Minor electrical system diagnostic or repair to support installation of an audit-driven ECM

8.9.4(a7) Minor roof repair to protect attic insulation that will be installed

8.9.4(a8) Mobile home skirting repair to prevent damage to sealed ducts or undercarriage insulation

- Flashing or proper caulking will be installed between the skirting and the manufactured home if required by the authority having jurisdiction.
- Skirting support (e.g., vinyl blowout rods, horizontal bracing for other types) will be placed in high-wind locations.

8.9.4(a9) Repair or installation of an appliance enclosure door (in support of an ECM appliance installation) that is missing, does not close properly, allows entry of combustion byproducts into the living space, or allows entry of inclement weather into the enclosure

8.9.4(a10) Minor adjustments or replacements to windows and doors (examples include: installing weatherstripping, shoes, thresholds, or a window for window/wall air conditioner)

- Replacement of damaged or missing window screens used to provide ventilation during whole house fan operation

8.9.4(a11) Rough framing repair (to support door/window energy efficiency upgrades)

8.9.4(a12) Attic/crawlspace access enlargement to allow installation of insulation

8.9.4(a13) Labor and materials, such as paint, associated with touch-up painting following wall insulation installation

8.9.4(a14) Other repairs necessary to protect or preserve an audit-driven ECM

8.9.4(b) Structural repairs and dwelling rehabilitation are not feasible within ECM Support.

8.9.5 Billing of LHR Line Items

8.9.5(a) Some examples of H&S Support and ECM Support line items are very similar, such as a water heater platform repair. To know where the platform must be billed, it must first be determined if the water heater itself must be billed to H&S or if its replacement can be justified as an energy efficiency upgrade.

8.9.5(a1) For LIHEAP: The LHR line item shall be used for any ECM Support measure or H&S Support measure/activity. This line item may not exceed the measure maximum as defined by contract unless an approved CSD waiver is granted.

8.9.5(a2) For DOE: The LHR–H&S Support line item may not exceed the measure maximum as defined by contract unless an approved CSD waiver is granted.

8.9.5(a3) For DOE: Where an energy audit or the DOE Priority List would be applied, the measure maximum for the "LHR–ECM Support" line item will be determined by the energy audit or the maximum amount will be limited by the Priority List. The cost for the incidental repair(s) must never make the SIR calculation for the total package of weatherization measures (Dwelling SIR) <1.0 or the LHR and its associated measure(s) are not feasible.

- The "LHR–ECM Support" line item must be included in the Dwelling SIR calculation when an energy audit is conducted. For details of how to calculate a Dwelling SIR, refer to the Appendix D Energy Audit/Priority List Protocol.
- If a dwelling is leveraged between DOE WAP and LIHEAP, LHR activities may be leveraged but shall be in compliance with LHR Policy guidance.

8.9.6 LHR Documentation

8.9.6(a) All LHR repairs (for H&S Support and ECM Support) require the following to be added or attached to the CSD 540 Dwelling Assessment form and maintained in the client file:

8.9.6(a1) Identification of the measure to be protected (required when installation is in support of a measure)

8.9.6(a2) A description of the LHR repair needed

8.9.6(a3) Justification for the installation of the LHR and

8.9.6(a4) Photo documentation of existing conditions

8.10. (DOE Only) Precautionary Measures

8.10.1 The measures in this section will be installed as Limited Home Repair - Health and Safety Support based on qualifying conditions.

8.10.2 Installation of a Soil Gas Retarder on Exposed Earthen Floors in Basements and Crawlspaces within the Thermal/Pressure Boundary

8.10.2(a) Install This Measure When:

8.10.2(a1) A basement, or an enclosed and unventilated crawlspace, has an exposed dirt floor and is located within the thermal/pressure boundary

8.10.2(a2) A soil gas retarder is not present, or the existing retarder is damaged and does not provide adequate coverage

8.10.2(b) Do Not Install This Measure When:

8.10.2(b1) The crawlspace or basement is not within the thermal/pressure boundary (i.e., floor insulation and crawlspace venting are installed, or will be installed within the weatherization program, in accordance with Section 39 Floor Insulation and Section 41 Crawlspace Ventilation)

8.10.2(b2) A soil gas retarder is already present on the crawlspace/basement floor (and is in good condition, without holes or tears)

8.10.2(b3) Installation of a dehumidifier is required in conjunction with the soil gas retarder, but cannot be installed or proper condensate drainage cannot be achieved

8.10.2(b4) Drainage issues are present that would allow water to drain toward the foundation wall and footing, including:

- Downspouts do not drain away from the home
- Grading slopes toward the foundation wall

8.10.2(b5) A suitable electrical outlet is not present in the crawlspace and one cannot be provided

8.10.2(b6) One or more mandatory environmental hazards or deferral conditions are present and cannot be corrected within the program scope (see Appendix E Health and Safety Requirements)

8.10.2(b7) The client refuses after measure benefits have been explained by the assessor

8.10.2(c) Installation Guidelines

8.10.2(c1) General Requirements

- The crawlspace/basement must be accessible in accordance with the clearance requirements in Section 1 General Installation Guidelines, Attic and Crawlspace Accessibility.
- All health and safety repairs or measure installations requiring access to the basement or enclosed/unventilated crawlspace shall be completed before the retarder is installed.
- If feasibility conditions for this measure are met, but the measure will not be installed for any reason, the entire dwelling shall be deferred.
- For mobile home installations: prior approval must be granted from the California Department of Housing and Community Development (HCD), or another authority having jurisdiction.
- For multi-family installations:
  - When only an individual multi-family unit in a multi-family building will be served, this measure is not feasible.
  - When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

8.10.2(d) Installation Procedure

8.10.2(d1) Pre-Installation Assessment

- The outside perimeter of the home shall be inspected for sources of moisture and drainage issues.
- The inside of the crawlspace/basement shall be assessed for:
  - Environmental or structural hazards as defined in Appendix E Health and Safety Requirements
  - Proper attachment of gas, water, and electrical lines to floor joists or framing members every 4 feet
  - Exhaust terminations and uncorrectable combustion appliance safety hazards
  - Electrical hazards

8.10.2(d2) Preparation of the Crawlspace

- Any issues identified during the inspection process shall be corrected before a soil gas retarder is installed.
- All vegetation and organic material, rocks, sharp objects, and debris shall be removed from the installation surface and disposed of properly.

8.10.2(d3) Installation of Soil Gas Retarder

- The soil gas retarder shall be installed per the Section 39 Floor Insulation, Installation of Vapor Retarder guidelines.

8.10.2(d4) Dehumidifier

- Installation of a dehumidifier in conjunction with the soil gas retarder will always be required for any unvented crawlspace or basement.
- The dehumidifier shall be installed in accordance with manufacturer's instructions and the local jurisdiction, and adhere to each of the installation components listed below.
- Location Requirements
  - The unit shall be installed in a location that:
    - Protects the unit from rain, flooding, or other sources of water
    - Supports proper airflow (i.e., a minimum of 12" from a wall or obstruction)
    - Provides sufficient clearance on all sides of the unit to allow filter removal and unit maintenance
  - The dehumidifier shall be installed in a level, plumb, and stable position.
  - The unit shall not be in direct contact with structural building members.
  - When installed in locations where flooding may occur, the unit shall be suspended per manufacturer's instructions.
- Electrical Requirements
  - Electrical supply provided shall be 120-volt, with a minimum 15-amp.
  - Proper circuit conductors and overcurrent protection (fuse or breaker) shall be present.
  - The outlet shall be:
    - A properly grounded three-prong receptacle with a functional grounding conductor.
    - Within 6' of the installation location, or as otherwise specified.
  - A GFCI-protected outlet is required unless otherwise specified.
  - The unit shall not share the receptacle with another appliance, or use an extension cord or adapter, unless explicitly allowed by the manufacturer.
- Condensate Control
  - A drain line, minimum 3/4" nominal pipe size, shall be installed for condensate drainage.
  - The condensate drain shall slope downward to a suitable drain site.
  - When required, a drain trap shall be installed in the condensate line.
  - A manufacturer-recommended condensate pump may be installed if a lift is required to properly drain condensate from the space.
- Flexible Ducts
  - Intake and exhaust ducts shall terminate on opposite sides of the crawlspace/basement, to ensure proper air circulation unless otherwise stated.
  - Ducts shall be secured to the manufacturer-provided duct collars.
  - Duct sizing shall be a minimum of:
    - 8" diameter, when used for duct runs of 10' or less.
    - 10" diameter, when duct run is more than 10'.

8.10.2(e) Post-Installation Guidelines

8.10.2(e1) Quality Check

- Combustion appliance safety testing must be performed following installation of the measure, in accordance with Appendix A Combustion Appliance Safety Protocol.
- The soil gas retarder shall:
  - Cover the entire crawlspace floor

- Be properly secured and the edges/overlaps sealed by at least 12”
- The dehumidifier shall be confirmed to be operating properly and all controls and safety devices shall be in place.

8.10.2(e2) Client Education

- Unless virgin resin or reinforced retarder material ≥10 mil was installed, the client shall be advised that the soil gas retarder is biodegradable, it will have a life span much shorter than the home (approximately 5 years), and will need to be replaced to remain effective.
- The client shall be educated on the importance of the proper operation of the dehumidifier to maintain structural integrity of the home and to reduce the likelihood of mold and mildew in the space.

8.10.2(e3) Clean-Up and Disposal Requirements

- Upon completion, the residence shall be returned to its original condition and left free of job-related dust and debris indoors and outdoors.

8.10.3 Installation of an Airtight Sump Pump/Well Pit Cover within the Thermal/Pressure Boundary

8.10.3(a) Install This Measure When:

8.10.3(a1) A solid, airtight cover is not in place

8.10.3(a2) An existing solid cover is damaged and does not seal properly

8.10.3(a3) The existing sump pump obtains water directly from the basement/crawlspace floor and no cover is in place or the existing solid cover does not have a self-sealing drain.

8.10.3(b) Do Not Install This Measure When:

8.10.3(b1) The sump pump/well pit is not within the thermal/pressure boundary

8.10.3(b2) A solid, sealed cover is already in place

8.10.3(b3) The existing sump pit is not vented properly and correction is not feasible

8.10.3(b4) Surrounding floor or basin lip is damaged preventing proper sealing of the cover and correction is not feasible

8.10.3(b5) The client refuses after measure benefits have been explained by the assessor

8.10.3(c) Installation Guidelines

8.10.3(c1) General Requirements

- Crawlspace must be accessible in accordance with the clearance requirements for attics and crawlspaces identified in the Section 1 General Installation Guidelines, Attic and Crawlspace Accessibility.
- All covers shall be installed in accordance with manufacturer’s instructions, Title 24, and the local jurisdiction.
- If feasibility conditions for this measure are met, but the measure will not be installed for any reason, the entire dwelling shall be deferred.
- This installation standard shall also be applicable to mobile home and multi-family installations.

8.10.3(d) Installation Procedure

8.10.3(d1) Pre-Installation

- The surrounding area shall be free of debris to prevent foreign objects from entering the pit during cover installation.
- The sump basin and surrounding floor shall be inspected for damages and cracks that may prevent proper sealing.

8.10.3(d2) Cover Installation

- The discharge opening shall be aligned with the pump’s discharge pipe.
- The cover shall be:
  - Installed in such a way that water can drain from above and below the sump cover

- Sealed to the mounting surface with silicone or the manufacturer's provided gasket
- Secured to the basin or floor per manufacturer's instructions

- When replacing a perforated cover with a solid cover, a self-sealing drain shall be present in the cover.
- The connections of the discharge pipe and vent pipe to the cover shall be tight and free of leaks.

8.10.3(d3) Vent Pipe Installation

- A vent pipe shall be installed and vented to the outdoors in accordance with the local jurisdiction, or at a minimum shall terminate a minimum of:
  - 12" above the surface of the roof, and
  - 10' from an openable window, mechanical intake, or opening into conditioned space that is less than 2' below the exhaust point, and
  - A minimum of 10' from any window or other opening in adjoining or adjacent buildings
- The vent pipe shall be labeled in accordance with Title 24 and the local jurisdiction.
- Vent fan
  - When a vent fan is required by the local jurisdiction:
    - The vent pipe shall be accessible
    - A vent fan shall be installed in-line with the vent system

8.10.3(e) Post-Installation Guidelines

8.10.3(e1) Quality Check

- The sump pump shall be checked to ensure proper operation.
- The sump pump cover shall be checked to ensure airtight sealing of the cover.
- All connections shall be verified to be tight and sealed, including the discharge pipe, vent pipe, and cable grommet.

8.10.3(e2) Client Education

- Client shall be educated on purpose of the sump cover and the importance of leaving the cover sealed.

8.10.3(e3) Clean-Up and Disposal Requirements

- Upon completion, the residence shall be returned to its original condition and left free of job-related dust and debris indoors and outdoors.

8.11 Window Egress (Conventional Homes)

8.11.1 When a measure will be installed that would affect the egress compliance of a dwelling, the following requirements shall apply.

8.11.1(a) Examples of these measures that may require egress considerations include, but are not limited to:

8.11.1(a1) Window-mount air conditioning units

8.11.1(a2) Window-mount evaporative cooling units

8.11.1(a3) Infiltration reduction activities

8.11.1(b) Egress requirements apply to all rooms used for sleeping.

8.11.1(c) When a sleeping room has no operable exterior door, at least one window must meet the egress requirements of local code and CRC, which places the following requirements on egress windows:

8.11.1(c1) Minimum net clear openable area of 5.7 sq. ft.

8.11.1(c2) Minimum width of 20"

8.11.1(c3) Minimum height of 24"

8.11.1 (c4) Maximum finished sill height of 44" above the floor

- For example, if the width of the opening is 26", the height must be 32" to achieve 5.7 sq. ft. of clear, openable area.

8.11.1 (d) Exception: A minimum net clear openable area of 5 sq. ft. is allowed on a “grade floor” opening/window where the sill height is not more than 44" above the finished ground level adjacent to the opening.

8.11.2 See Table 2-3 for conventional home egress window area calculations.

TABLE 2-3: EGRESS WINDOW AREA† (CONVENTIONAL HOME)*

H/W†	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
20																			5.83
21																	5.83	5.98	6.13
22															5.81	5.96	6.11	6.26	6.42
23													5.75	5.91	6.07	6.23	6.39	6.55	6.71
24												5.83	6.00	6.17	6.33	6.50	6.67	6.83	7.00
25										5.73	5.90	6.08	6.25	6.42	6.60	6.77	6.94	7.12	7.29
26									5.78	5.96	6.14	6.32	6.50	6.68	6.86	7.04	7.22	7.40	7.58
27								5.81	6.00	6.19	6.38	6.56	6.75	6.94	7.13	7.31	7.50	7.69	7.88
28							5.83	6.03	6.22	6.42	6.61	6.81	7.00	7.19	7.39	7.58	7.78	7.97	8.17
29						5.84	6.04	6.24	6.44	6.65	6.85	7.05	7.25	7.45	7.65	7.85	8.06	8.26	8.46
30					5.83	6.04	6.25	6.46	6.67	6.88	7.08	7.29	7.50	7.71	7.92	8.13	8.33	8.54	8.75
31				5.81	6.03	6.24	6.46	6.67	6.89	7.10	7.32	7.53	7.75	7.97	8.18	8.40	8.61	8.83	9.04
32			5.78	6.00	6.22	6.44	6.67	6.89	7.11	7.33	7.56	7.78	8.00	8.22	8.44	8.67	8.89	9.11	9.33
33		5.73	5.96	6.19	6.42	6.65	6.88	7.10	7.33	7.56	7.79	8.02	8.25	8.48	8.71	8.94	9.17	9.40	9.63
34		5.90	6.14	6.38	6.61	6.85	7.08	7.32	7.56	7.79	8.03	8.26	8.50	8.74	8.97	9.21	9.44	9.68	9.92
35	5.83	6.08	6.32	6.56	6.81	7.05	7.29	7.53	7.78	8.02	8.26	8.51	8.75	8.99	9.24	9.48	9.72	9.97	10.21
36	6.00	6.25	6.50	6.75	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.75	9.00	9.25	9.50	9.75	10.00	10.25	10.50
37	6.17	6.42	6.68	6.94	7.19	7.45	7.71	7.97	8.22	8.48	8.74	8.99	9.25	9.51	9.76	10.02	10.28	10.53	10.79
38	6.33	6.60	6.86	7.13	7.39	7.65	7.92	8.18	8.44	8.71	8.97	9.24	9.50	9.76	10.03	10.29	10.56	10.82	11.08

† Area is measured in sq. ft., height (H) and width (W) are measured in inches
*Required opening: 5.7 sq. ft.

8.12. Window Egress (Mobile Homes)

8.12.1 Egress requirements apply to all rooms used for sleeping.

8.12.1 (a) When a sleeping room has no operable exterior door, at least one window must meet the following opening requirements:

8.12.1 (a1) Minimum 5 sq. ft. of clear, openable area

8.12.1 (a2) Minimum 22" of clear, openable horizontal and vertical dimension (Fig. 2-8).

- For example, if the width of the opening is 22", the height must be 33" to achieve 5 sq. ft. of clear, openable area.

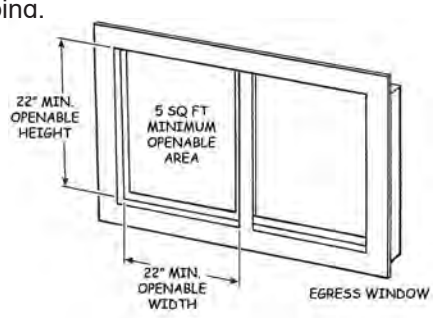


FIG. 2-8: REPLACEMENT EGRESS WINDOW REQUIREMENTS FOR MOBILE HOMES

8.12.2 See Table 2-4 for mobile home egress window area calculations.

TABLE 2-4: EGRESS WINDOW AREA† (MOBILE HOME)*

H/W†	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
20														5.14	5.28	5.42	5.56	5.69	5.83
21												5.10	5.25	5.40	5.54	5.69	5.83	5.98	6.13
22										5.04	5.19	5.35	5.50	5.65	5.81	5.96	6.11	6.26	6.42
23									5.11	5.27	5.43	5.59	5.75	5.91	6.07	6.23	6.39	6.55	6.71
24								5.17	5.33	5.50	5.67	5.83	6.00	6.17	6.33	6.50	6.67	6.83	7.00
25						5.03	5.21	5.38	5.56	5.73	5.90	6.08	6.25	6.42	6.60	6.77	6.94	7.12	7.29
26					5.06	5.24	5.42	5.60	5.78	5.96	6.14	6.32	6.50	6.68	6.86	7.04	7.22	7.40	7.58
27				5.06	5.25	5.44	5.63	5.81	6.00	6.19	6.38	6.56	6.75	6.94	7.13	7.31	7.50	7.69	7.88
28			5.06	5.25	5.44	5.64	5.83	6.03	6.22	6.42	6.61	6.81	7.00	7.19	7.39	7.58	7.78	7.97	8.17
29		5.03	5.24	5.44	5.64	5.84	6.04	6.24	6.44	6.65	6.85	7.05	7.25	7.45	7.65	7.85	8.06	8.26	8.46
30		5.21	5.42	5.63	5.83	6.04	6.25	6.46	6.67	6.88	7.08	7.29	7.50	7.71	7.92	8.13	8.33	8.54	8.75
31	5.17	5.38	5.60	5.81	6.03	6.24	6.46	6.67	6.89	7.10	7.32	7.53	7.75	7.97	8.18	8.40	8.61	8.83	9.04
32	5.33	5.56	5.78	6.00	6.22	6.44	6.67	6.89	7.11	7.33	7.56	7.78	8.00	8.22	8.44	8.67	8.89	9.11	9.33
33	5.50	5.73	5.96	6.19	6.42	6.65	6.88	7.10	7.33	7.56	7.79	8.02	8.25	8.48	8.71	8.94	9.17	9.40	9.63
34	5.67	5.90	6.14	6.38	6.61	6.85	7.08	7.32	7.56	7.79	8.03	8.26	8.50	8.74	8.97	9.21	9.44	9.68	9.92
35	5.83	6.08	6.32	6.56	6.81	7.05	7.29	7.53	7.78	8.02	8.26	8.51	8.75	8.99	9.24	9.48	9.72	9.97	10.21
36	6.00	6.25	6.50	6.75	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.75	9.00	9.25	9.50	9.75	10.00	10.25	10.50
37	6.17	6.42	6.68	6.94	7.19	7.45	7.71	7.97	8.22	8.48	8.74	8.99	9.25	9.51	9.76	10.02	10.28	10.53	10.79
38	6.33	6.60	6.86	7.13	7.39	7.65	7.92	8.18	8.44	8.71	8.97	9.24	9.50	9.76	10.03	10.29	10.56	10.82	11.08

† Area is measured in sq. ft., height (H) and width (W) are measured in inches
*Required opening: 5 sq. ft.

8.13. Window Orientation

8.13.1 The following are two procedures to determine compass orientation of a particular window for installation of measures, such as shade screens, storm windows, etc. (Fig. 2-9).

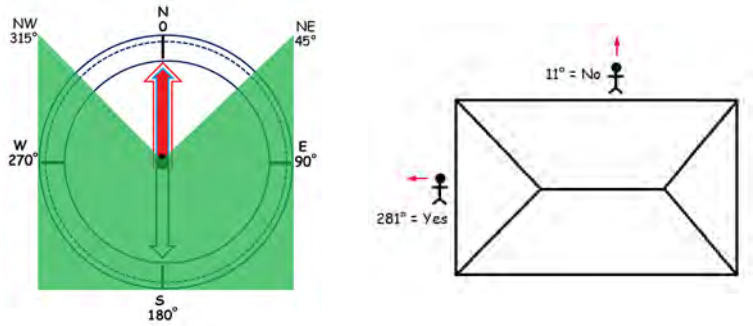


FIG. 2-9: ALLOWED ORIENTATIONS ONLY ON WINDOWS FACING COMPASS READINGS WITHIN THE DARKENED AREA

8.13.1(a) Window and wall orientation for an energy audit are compass points as described in Appendix D Energy Audit/Priority List Protocol.

8.13.2 Cell Phone Compass Application Procedure

8.13.2(a) Set the cell phone application to read true north before taking a reading.

8.13.2(b) Stand with your back to the window being assessed.

8.13.2(c) Keep the compass perpendicular to the window.

8.13.2(d) Hold the cell phone level.

8.13.2(e) Record the degree number indicated at the top of the compass face (final reading).

8.13.3 Magnetic Compass Procedure

8.13.3(a) Follow the compass manufacturer's instructions.

8.13.3(b) Stand with your back to the window being assessed.

8.13.3(c) Point the compass in the direction that is perpendicular to the window.

8.13.3(d) Hold the compass level by its base.

8.13.3(e) Rotate the compass housing until the red magnetic needle lines up inside the orienting arrow outline within the compass housing. (Fig. 2-10)

8.13.3(f) Record the degree number sighted directly across the compass face, then add the appropriate declination factor from Table 2-5 to get the final reading.

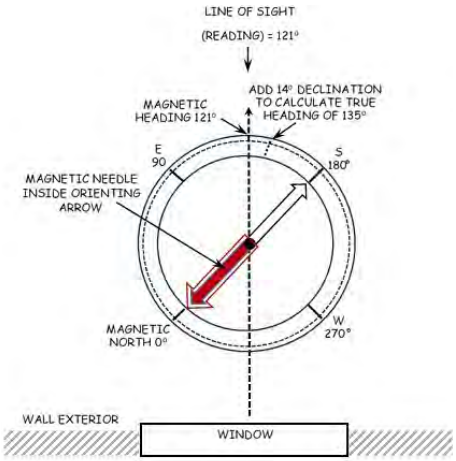


FIG. 2-10: DECLINATION ADJUSTMENT FOR A MAGNETIC COMPASS

8.13.3(g) When using a declination-adjustable compass, it is acceptable to turn the compass housing with the orienting arrow to automatically account for the declination factor in accordance with Table 2-5 and the manufacturer's instructions.

TABLE 2-5: DECLINATION* ADJUSTMENT BY REGION

Geographic Region for the Home Being Evaluated	Compass Declination
Redding	+15
Sacramento	+14
Bakersfield	+13
San Diego	+12
*Declination is a "correction factor" that is added to a magnetic compass reading to indicate true north.	

8.14. Safety Glass in Windows and Doors

8.14.1 When glazing in a door or window will be replaced, or when a door or window will be replaced, the installed measure shall meet the safety glazing requirements below.

8.14.2 Safety glazing must be permanently labeled and installed per the current CRC requirements for windows (Fig. 2-11), as summarized below:

FIG. 2-11: REQUIRED LOCATIONS FOR SAFETY GLASS

8.14.2(a) Safety glass is required in any window adjacent to a door where both of the following apply:

8.14.2(a1) The nearest vertical edge is within 24" of the door and

8.14.2(a2) The bottom edge is <60" above the floor

- Exception: Safety glass is not required when there is an intervening wall or other permanent barrier between the door and the glazing.

8.14.2(b) Safety glass is required in panes >9 sq. ft. where all of the following apply:

8.14.2(b1) The bottom edge is <18" above the floor and

8.14.2(b2) The top edge is >36" above the floor and

8.14.2(b3) A walking surface is within 36" horizontally of the window

8.14.2(b4) Exceptions: As defined in the CRC.

8.14.2(c) Safety glass is required when the bottom edge of the glazing is <36" above the walking surface of a stairway or landing.

8.14.2(d) Safety glass is required in shower and bathtub enclosures for exterior windows <60" above the floor of the enclosure.

8.14.2(e) Safety glass is required in all doors with glazing.

8.14.2(f) Exceptions: Jalousie windows and windows with panes <3" in width or height.

9. ECIP EHCS POLICIES

9.1 When ECIP EHCS funds are used for repair, replacement, or new installation for certain heating, cooling, and/or water heating appliances, it shall comply with EHCS policy, which can be found on the CSD Providers' website.

9.2 For heating and cooling EHCS requirements, refer to Section 4 Heating and Cooling.

9.3 For water heating EHCS requirements, refer to Section 13 Water Heaters—Gas, Electric and Heat Pump.

9.4 The CSD 51 SWEATS and PSPS Preparedness Intake form and CSD 57 ECIP EHCS Assessment form must include proof of all of the following:

9.4.1 The client meets the income and dwelling eligibility

9.4.2 The client has insufficient funds to repair/replace the appliance

9.4.3 The appliance meets one or more of the repair/replacement criteria below.

9.5 ECIP EHCS Emergency Assistance Timeframes

9.5.1 When contacted by a client for ECIP EHCS assistance, the agency must conduct CAS testing (see Appendix A Combustion Appliance Safety Protocol) to identify all hazardous and non-hazardous conditions pertaining to the appliance before any repair or replacement work is completed.

9.5.2 ECIP EHCS services must mitigate and completely resolve the emergency within the emergency assistance timeframes.

9.5.3 When a hazard is identified, the agency must, at a minimum, officially cap or disable the qualifying dangerous appliance within 18 hours. In addition, the agency must:

9.5.3(a) Provide client education

9.5.3(b) Offer to make available temporary portable heating or cooling devices:

9.5.3(b1) Within 18 hours to any applicant with a qualifying "medical condition"

9.5.3(b2) Within 18 hours to any elderly or disabled applicant whose wood stove is inoperable or for whom handling the fuel is a hardship

9.5.3(b3) Within 48 hours to all other applicants

9.5.4 The agency's decision to repair or replace the appliance shall be delivered in writing to each applicant for whom service will not be provided (dwelling deferral), no later than 30 calendar days after the initial appliance assessment.

9.5.5 ECIP EHCS jobs shall be scheduled and completed to the extent practicable ahead of all nonemergency weatherization and no later than the end of the appropriate heating or cooling season:

9.5.5(a) Space heater or cooling appliance repairs or replacements must be completed no later than the end of the current or immediately upcoming heating season.

9.5.5(b) If a heater or cooler is repaired or replaced after the end of the current or immediately upcoming season, CSD's pre-approval is required.

10. LOAN OF PORTABLE APPLIANCES

10.1 Under one component of the Severe Weather Energy Assistance and Transportation Services (SWEATS) Policy, certain portable heating, cooling, or electricity producing appliances may be loaned to low-income persons on an interim basis, as needed and with CSD approval, when a state-declared crisis or emergency occurs that temporarily deprives occupants of heating, cooling, or electricity required to maintain their health, safety, and essential comfort level.

10.2 Portable appliances may be loaned until repair or replacement of an existing heating and/or cooling appliance is completed or a permanent heating and/or cooling solution is reached.

10.3 Loans of portable appliances must be made to conform with the latest published SWEATS policy available on the CSD Providers' website.

10.4 The CSD 52 Temporary Energy Portable Appliance Loan Agreement & Waiver shall be completed and kept in the client file.

10.5 Portable equipment types available under the SWEATS Policy are:

10.5.1 Air conditioner

10.5.2 Evaporative cooler

10.5.3 Space heater

10.5.4 Fan

10.5.5 Generator (and fuel to operate it)

11. MATERIAL SPECIFICATIONS

11.1. Access Hatches

11.1.1 Refer to Section 32 Infiltration Reduction, Material Specifications.

11.2. Cover Plates

11.2.1 Size and Shape

11.2.1 (a) Cover plates shall:

11.2.1 (a1) Be plain (non-decorative) plastic only

11.2.1 (a2) Wood or metal not allowed

11.2.1 (a3) Properly fit the application

11.2.1 (a4) Oversize and blank plates allowed where required

11.2.1 (a5) Be of standard rectangular shape to fit standard electrical boxes

11.2.1 (a6) Be standard color (ivory, white, almond, or black)

11.2.1 (a7) Have color-matched screws

11.2.1 (b) No cover plates shall be allowed with custom colors or decorative design.

11.3. Domestic Clothes Dryer Moisture Exhaust

11.3.1 All Ducts

11.3.1 (a) A gas or electric clothes dryer moisture exhaust shall:

11.3.1 (a1) Be of rigid metal and have a smooth interior surface

11.3.1 (a2) Be minimum 4" in diameter

11.3.1 (a3) Comply with clothes dryer manufacturer's specifications and applicable local code

11.3.1 (a4) Be no more than 14' total in length and include no more than two 90° elbows

11.3.2 Rigid Duct with Smooth Interior Surface

11.3.2 (a) Galvanized steel: Minimum 26 gauge

11.3.2(b) Aluminum: Minimum 24 gauge

11.3.2(c) Exception: UL-listed, flexible clothes dryer transition duct not more than 6' in length may be used to connect the dryer to a metal exhaust duct. Plastic venting material will not be used.

11.3.2(d) Flexible transition duct shall not be concealed within the construction.

11.3.3 Moisture Exhaust Duct Terminations

11.3.3(a) The termination shall be manufactured for use with dryers and made of aluminum, sheet metal, or ultraviolet (UV)-protected plastic with no mesh/screen

11.3.4 Dampers

11.3.4(a) A metal or plastic gravity-type backdraft damper shall be present in the termination.

11.3.5 Duct Connections Clamps, and Hangers

11.3.5(a) Duct connectors shall be listed stainless steel or impact-resistant plastic hose clamp style bands to be installed around a duct exterior.

11.3.5(b) Screws shall not be used to connect duct sections.

11.3.5(c) In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material.

11.3.5(d) Duct hangers shall be rust- and corrosion-resistant.

11.4. Exhaust Fan Vent Extension

11.4.1 All exhaust ducts shall comply with manufacturer's instructions and applicable local code (e.g., for flame spread index).

11.4.2 Rigid Duct

11.4.2(a) Galvanized steel: Minimum 26 gauge

11.4.2(b) Aluminum: Minimum 24 gauge

11.4.2(c) Polyvinyl chloride (PVC) smooth plastic pipe: Minimum schedule 80

11.4.3 Flexible Duct

11.4.3(a) Semi-rigid metallic aluminum: Minimum 0.0065" thick, listed to UL-2158A

11.4.4 Exhaust Duct Terminations and Dampers

11.4.4(a) Exhaust duct terminations and dampers shall be aluminum, sheet metal, or UV-protected plastic.

11.4.4(b) A compatible metal or plastic gravity-type backdraft damper shall be present in the system.

11.5. Floor/Platform Repair for Appliances

11.5.1 Plywood Sheet

11.5.1(a) Horizontal surface:

11.5.1(a1) Minimum 1" thickness

11.5.1(a2) C-grade face or better and bonded with exterior glue resin

11.5.1(b) Shear surround:

11.5.1(b1) Minimum ½" thickness

11.5.1(b2) C-grade face or better and bonded with exterior glue resin

11.5.1(c) Primer shall be applied on all new wood used for outdoor applications.

11.5.2 Structural Wood Members

11.5.2(a) Pressure-treated or redwood

11.5.2(b) 2" x 4" or larger

11.5.3 Fasteners

11.5.3(a) Minimum #8 size steel screws

11.5.3(b) Rust- and corrosion-resistant

11.5.3(c) Nails are not allowed

11.5.4 Drywall for Indoor Appliance Platforms

11.5.4(a) Minimum ½" thickness

11.5.4(b) Moisture- and mold-resistant (e.g., green board)

11.5.5 Drywall Screws

11.5.5(a) Drywall screws shall be sized to penetrate solid wood a minimum ⅝".

11.5.6 Metal Water Heater Stand

11.5.6(a) A metal water heater stand shall be:

11.5.6(a1) UL-listed (or equivalent) and compliant with local code

11.5.6(a2) Constructed of galvanized steel or aluminum

11.5.6(a3) Appropriately sized to support the entire footprint of the water heater

11.6. Minor Roof Repair

11.6.1 General Requirements

11.6.1(a) Roof repair shall be completed only to protect installed measures from the weather.

11.6.1(b) Whenever possible, replacement materials shall match existing roofing materials in size, color, and quality.

11.6.1(c) All materials shall be UL-listed (or equivalent) and compliant with local codes.

11.6.2 Required Safety Equipment

11.6.2(a) All roof-related work shall be conducted in accordance with all applicable Cal/OSHA regulations (e.g., wearing a safety harness, removal of materials, etc.).

11.7. Mobile Home Skirting Repair

11.7.1 All Jobs

11.7.1(a) The actual skirting materials needed for each job shall be identified by the assessor, but standard materials specifications are provided below.

11.7.1(b) Issues related to moisture and drainage, the presence of pests, etc. will be corrected before skirting work begins.

11.7.1(c) Existing skirting support material will be structurally sound and completely intact; any damaged framing will be replaced.

11.7.1(d) Skirting will be installed to allow for movement due to expansion and contraction (i.e., no screws or nails directly through panels).

11.7.2 All Skirting Materials

11.7.2(a) All materials shall be compliant with applicable HCD requirements.

11.7.2(b) When feasible, materials shall match existing skirting materials including size, color, and quality.

11.7.3 Wood Skirting

11.7.3(a) All wood within 6" of earth or concrete shall be treated wood or wood with natural resistance to decay (i.e., redwood, cedar, or pressure-treated fir).

11.7.3(b) Frame structure shall be minimum 2" x 2" in size.

11.7.3(c) Plywood or composite sheeting shall be exterior-grade, have a minimum thickness of ⅜", and have plies or fibers bonded with exterior glue resin.

11.7.3(d) Board siding shall have a minimum thickness of ½".

11.7.4 Primer

11.7.4(a) Primer shall be UV- and stain-resistant exterior-grade material.

11.7.4(b) At least one application of primer is required on all new wood skirting.

11.7.5 Fasteners

11.7.5(a) Fasteners shall be rust- and corrosion-resistant steel.

11.7.6 Ventilation Screen

11.7.6(a) Screens shall:

11.7.6(a1) Be ¼" corrosion-resistant metal

11.7.6(a2) Match the existing screens when feasible

11.8. Rough Framing to Support Window or Door Installation

11.8.1 All Jobs

11.8.1(a) The actual materials needed shall be identified by the installer after the window or door jamb is removed, but standard materials specifications are provided below.

11.8.2 Dimensional Framing Lumber

11.8.2(a) Douglas fir of standard-grade or better

11.8.3 Furring Strip

11.8.3(a) Douglas fir or redwood of standard-grade or better

11.8.4 Plywood

11.8.4(a) APA – The Engineered Wood Association (APA)-rated, exterior-grade

11.8.5 Oriented Strand Board (OSB)

11.8.5(a) APA-rated, exterior-grade

11.8.6 Fasteners

11.8.6(a) Fasteners shall comply with local code requirements.

11.9. Gas Pipes and Valves

11.9.1 Gas valves must be UL-listed and American Gas Association (AGA)- or Canadian Standards Association (CSA)-certified.

11.9.2 Gas flexible connectors must be International Association of Plumbing and Mechanical Officials (IAPMO)–listed epoxy-coated or stainless steel units.

11.9.3 Pilot tubing shall be aluminum.

11.9.3(a) Copper is not allowed.

11.9.4 Fuel-gas piping shall be selected, sized, and installed per CMC, Chapter 13.

11.9.4(a) Copper gas lines are not allowed.

11.10. Electrical Materials

11.10.1 Splicing connectors— shall be UL-listed for the location (dry or damp/wet)

11.10.2 Electrical receptacles— shall be UL-listed for the location (dry or damp/wet)

11.10.3 GFCI receptacles or switches— shall be UL-listed for the location (dry or damp/wet)

11.10.4 Three-prong adapters— shall be UL-listed

11.10.5 Ground rods— shall be copper-bonded and UL-listed

11.11. Installation of a Soil Gas Retarder on Exposed Earthen Floors in Basements and Crawlspaces within the Thermal/Pressure Boundary

11.11.1 Measure Effective Useful Life

11.11.1(a) LIHEAP: Not applicable

11.11.1(b) DOE:

11.11.1(b1) Vapor Retarder: 5 years

11.11.1(b2) Dehumidifier: 5 years

11.11.2 Soil gas retarder shall be:

11.11.2(a) Class I vapor retarder with a perm rating of ≤0.1

11.11.2(a1) Can be ≥6 mil sheet polyethylene or unperforated aluminum foil (e.g., foil/scrim/kraft)

11.11.2(b) Class II vapor retarder with a perm rating of 0.1 – 1.0 (semi-impermeable)

11.11.2(b1) Can be sheet polyethylene

11.11.2(c) In accordance with tear- and puncture-resistance standard ASTM E1745

11.11.3 Crawlspace Seaming Tape

11.11.3(a) Moisture-resistant polyethylene or butyl tape

11.11.3(b) Minimum 3” width

11.11.4 Mechanical Fasteners

11.11.4(a) Shall be concrete nails or Christmas tree fasteners, at least 1” in length and non-corrosive

11.11.5 Dehumidifier

11.11.5(a) Energy Star-certified

11.11.5(b) Listed in the CEC Modernized Appliance Efficiency Database System (MAEDbS)

11.11.5(c) Provide a minimum of 70 pints of moisture removal per day for every 1000 sq. ft. of crawlspace floor area

11.11.5(d) Minimum 5-year manufacturer warranty

11.11.6 Flexible Duct

11.11.6(a) Ducts shall conform to National Fire Protection Association (NFPA) 90B and UL 181 (Class I).

11.11.6(b) Non-metallic insulated ducts with air-permeable core are not allowed.

11.12. Installation of an Airtight Sump Pump/Well Pit Cover within the Thermal/Pressure Boundary

11.12.1 Measure Effective Useful Life

11.12.1(a) LIHEAP: Not applicable

11.12.1(b) DOE: 5 years

11.12.2 Sump pump covers shall be:

11.12.2(a) Polyethylene structural foam construction

11.12.2(b) Solid, not perforated

11.12.2(c) Basin cap or pedestal cover type

11.12.2(c1) Access panel must be sealable for pedestal-type covers.

11.12.2(d) Equipped with pass-throughs for:

11.12.2(d1) Discharge pipe

11.12.2(d2) Vent pipe

11.12.2(d3) Electrical cords

11.12.2(e) Securable to the floor or existing basin

11.12.2(f) Shall be equipped with:

11.12.2(f1) A cover gasket

11.12.2(f2) A self-sealing drain, when the sump pit is designed for water to drain directly into the pit from the basement/crawlspace floor

11.12.3 Sealant

11.12.3(a) Latex sealants

11.12.3(a1) Latex, acrylic latex, and siliconized acrylic

11.12.3(a2) Conformance to ASTM C834

11.12.3(b) Elastomeric joint sealants

11.12.3(b1) Polysulfide, polyurethane, and silicone

11.12.3(b2) Conformance to ASTM C920

11.12.4 Vent Pipe

11.12.4(a) Minimum 3” ABS, PVC, or equivalent gas-tight pipe.

12. WARRANTY

12.1. All General Installation Guideline Warranties

12.1.1 Unless otherwise stated in item 11, warranties shall be:

12.1.1(a) Materials—1 year

12.1.1(b) Contractor—1 year

2. Carbon Monoxide Alarms

Table of Contents

Carbon Monoxide Alarms

1. MEASURE OBJECTIVES

1.1 Functioning carbon monoxide (CO) alarms are required to warn occupants of harmful CO levels in a building.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 A combustion appliance or fireplace is present or will be installed or

2.2.2 The dwelling has an attached garage or

2.2.3 An alarm is needed to meet Location Requirements or

2.2.4 An alarm is required by local jurisdiction or

2.2.5 An existing CO alarm:

2.2.5(a) Required: Is ≥5 years old or

2.2.5(b) Optional: Is ≥2 years old or

2.2.5(c) Date of manufacture cannot be determined or

2.2.5(d) Does not function properly when the “Test” button is pressed. (Do not replace batteries.)

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 An existing CO alarm:

3.1.1 Is operable and

3.1.2 Is <2 years old and

3.1.3 Meets Location Requirements

3.2 Installation would violate the Appendix E Health and Safety Requirements

3.3 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Location Requirements

4.1.1(a) CO alarms shall be installed on an interior wall whenever possible.

4.1.1(a1) Installation on a ceiling with insulation ≥R-11 is an alternative when there is no acceptable interior wall location and the ceiling does not have a presumed asbestos-containing textured ceiling.

4.1.1(a2) Installation on an exterior wall is not allowed.

4.1.1(b) The following locations require functioning CO alarms:

4.1.1(b1) Outside of and within 15' of all bedrooms and other areas used for sleeping (Fig. 2-1)

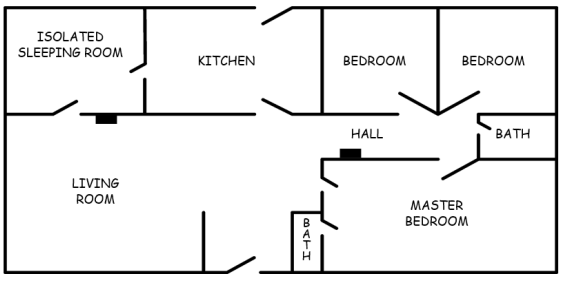


FIG. 2-1: CO ALARMS IN A ONE-STORY HOUSE (WITHIN 15' OF EACH BEDROOM)

4.1.1 (b2) Inside an area used for sleeping (including a garage, den, living room, etc.) if:

- There is no acceptable location to install the alarm outside the room or
- The sleeping area contains a combustion appliance, including a fireplace or insert

4.1.1 (b3) On each level (story) in dwellings with basements or multiple stories (Fig. 2-2):

- Basement location: On the wall near the entry to the stairs
- Other stories and habitable attic: On a wall in a central location

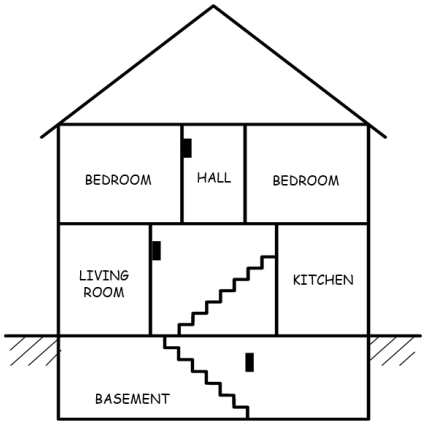


FIG. 2-2: CO ALARMS IN MULTI-STORY HOUSE

4.1.1 (c) Locations not allowed:

4.1.1 (c1) In a garage or unconditioned space, unless it is used for sleeping

- Exception: A CO alarm is required in a basement

4.1.1 (c2) In an appliance enclosure

4.1.1 (c3) Areas of extreme humidity, such as near a bath, shower, or laundry room

4.1.1 (c4) Areas of temperature extremes, such as:

- On the interior of an outside wall or
- On a ceiling with <R-11 insulation

4.1.1 (c5) In locations with limited air circulation, such as:

- Behind furniture or draperies, or behind a door in opened position
- Near an inside corner, in a vaulted ceiling, in an alcove or closet, etc.

4.1.1 (c6) In a storage area for household chemicals

4.1.1 (c7) In areas that are excessively greasy or dusty

4.1.1 (c8) On surfaces where asbestos-containing materials (ACM) or potential ACM will be disturbed

4.1.1 (c9) In locations specified by the manufacturer to be avoided

4.1.2 Clearances

4.1.2 (a) Install CO alarms:

4.1.2 (a1) 5'–6' above the floor

- Exception: The alarm may be mounted as low as 4' above the floor for adult occupants when:
  - An occupant is handicapped and using a wheelchair or
  - An occupant's height justifies a lower location

4.1.2 (a2) At least 1' away from the ceiling/wall junction

4.1.2 (a3) At least 3' away from:

- The air path of supply registers, return grilles, fresh air vents, and exhaust fans
- A door or opening to a moisture source, such as:
  - A bathroom that contains a bathtub or shower
  - A laundry room with a washer or sink

4.1.2 (a4) At least 5' horizontally from the following:

- Cooking appliances (gas or electric) (Fig. 2-3)

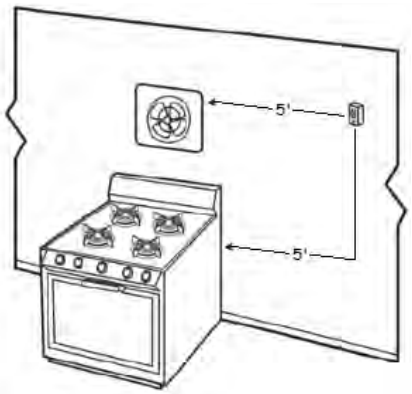


FIG. 2-3: MINIMUM 5' HORIZONTAL DISTANCE BETWEEN CO ALARM AND APPLIANCE

- Openable windows or outside doors
- Ceiling fans
- Drafty locations (such as shell leaks)
- A floor furnace, other heater, or water heater
- A source of chemical odor, such as a diaper pail or cat litter box

4.1.2(a5) Distances required by the manufacturer, which may be greater

4.1.3 Hardwired CO Alarms

4.1.3(a) New hardwired CO alarm systems shall only be installed when required for a hearing-impaired person or by the local jurisdiction (requires a program waiver).

4.1.3(b) Replacing an alarm in an existing hardwired CO alarm system is allowed when replacement with a battery-powered alarm is not feasible or not allowed by the local jurisdiction.

4.1.3(c) Installation shall be performed by an qualified technician.

4.1.3(d) The circuit powering the alarm(s) shall be 120-volt alternating current (AC), 60 Hz, and shall not be controlled by a switch, dimmer, ground fault circuit interrupter (GCFI), or arc fault circuit interrupter.

4.1.3(e) The alarm shall be mounted over a standard wiring junction box.

4.2. Installation Procedure

4.2.1 Existing Alarms

4.2.1(a) An existing alarm in an incorrect location shall be left in place.

4.2.1(a1) Batteries may be removed from an existing alarm to eliminate nuisance alarms if a new alarm is installed to provide adequate protection for that location.

4.2.2 Alarm Mounting

4.2.2(a) Mount the alarm securely so it cannot be detached without removing at least one screw.

4.2.2(b) If requested by a landlord or property owner, tamper-resistant mounting screws may be used for mounting.

4.2.3 The installation date shall be written in permanent ink on the alarm.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 Common area installation (e.g., in a boiler room, laundry room, hallway, etc. within the same thermal boundary as the dwelling units) for this measure is not allowed when only an individual unit in a multi-family building will be served (unless required by the local jurisdiction in conjunction with repair/replacement of a specific common area appliance).

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is a DOE Health & Safety (H&S) measure.

7.1.1 (a) H&S measures must be installed when feasible. If the client refuses the measure, or it cannot be physically installed due to a dwelling condition, the dwelling must be deferred.

7.1.1 (b) When installing this measure as part of the Audit path work scope, a Measure SIR and Dwelling SIR are not required.

7.1.1 (c) When installing this measure as part of the Priority List (PL) path work scope, this measure is considered Mandatory, and the measure must be addressed before other PL measures are possible.

7.1.1 (c1) Mandatory PL H&S measures include: carbon monoxide (CO) alarms, CVA venting, kitchen exhaust, lead-safe weatherization, LHR-H&S support, mechanical ventilation, and smoke alarms.

7.1.1 (d) When this measure is paid for by LIHEAP, or is cost-shared with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/Priority List Protocol.

7.1.2 Install CO alarms in every home where alarms are not present or are inoperable in compliance with ASHRAE 62.2-2016.

7.1.3 Replace functional CO alarms only when the existing alarm(s) are beyond the manufacturer's stated lifetime.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2 (a) If required by local code, the excerpt from the local code must be included in the client file or provided to CSD upon request.

7.2.2 (b) Excerpted from 2017 SWS 2.0301.2:

7.2.2 (b1) Hardwired CO detection or warning equipment will be installed in accordance with the ASHRAE 62.2 or as required by the authority having jurisdiction.

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

7.2.2 (b2) Battery-operated CO detection or warning equipment will be installed in accordance with the ASHRAE 62.2 and manufacturer specifications as required by the authority having jurisdiction.

7.2.3 Mobile Home

7.2.3 (a) Requirements for mobile homes are the same as those for single-family homes.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Each installed alarm shall be tested.

8.2. Client Education

8.2.1 Both verbal and written instructions (which may include unit packaging) shall be provided regarding:

8.2.1 (a) Maintenance of the alarm (e.g., periodic cleaning, protection from being painted, etc.)

8.2.1 (b) How to check for a low-level CO reading and testing of the alarm

8.2.1 (c) Response to an activated alarm

8.2.1(d) Response to failure signal (how to request replacement of the alarm or battery should failure occur within the warranty period)

8.2.2 Both verbal and written educational information shall be provided about:

8.2.2(a) CO and its effects on the human body

8.2.2(b) The symptoms associated with CO poisoning

8.2.3 Tamper-resistant CO alarm installations

8.2.3(a) The landlord or property owner will be provided a wrench for removal of tamper-resistant screws.

8.3. Clean-Up and Disposal Requirements

8.3.1 Packaging materials that include manufacturer's instructions or warranty information will be given to the customer.

8.3.2 All other installation and packaging materials shall be removed from the premises and disposed of properly.

8.3.3 Recycle CO alarms and batteries according to local requirements.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 4 years

9.1.2 DOE: Not applicable to this measure

9.2 Battery-powered CO alarms shall:

9.2.1 Be Underwriters Laboratories (UL)-tested and UL-listed to the latest American National Standards Institute/UL 2034 standard and on the state fire marshal’s list of approved products

9.2.2 Be single-purpose alarms (CO only)

9.2.3 Be equipped with a non-rechargeable, non-removable, lithium-type (minimum 10-year life) battery

9.2.4 Have an electrochemical sensor and a digital readout that displays the current CO level as low as 10 parts per million

9.2.5 Provide audible and visual warning signals when an internal malfunction occurs (e.g., electrical short or failure), the sensor’s life has expired, or the battery is at the end of its useful life

9.3 Hardwired CO alarms shall also:

9.3.1 Have factory-installed lithium battery back-up

9.3.2 Be interconnected when required by the local jurisdiction

10. WARRANTY

10.1 Manufacturer—10 years

10.2 Contractor—1 year

3. Smoke Alarms

Table of Contents

Smoke Alarms

1. MEASURE OBJECTIVES

1.1 Functioning smoke alarms are required to warn occupants of fire or smoke in a building.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 A smoke alarm is needed to meet Location Requirements or

2.2.2 A smoke alarm is required by the local jurisdiction or

2.2.3 An existing smoke alarm:

2.2.3(a) Required: Is ≥10 years old or

2.2.3(b) Optional: Is ≥8 years old or

2.2.3(c) Date of manufacture cannot be determined or

2.2.3(d) Does not function properly when the "Test" button is pressed. (Do not replace batteries.)

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 An existing smoke alarm:

3.1.1 Is operable and

3.1.2 Is <8 years old and

3.1.3 Meets Location Requirements

3.2 Installation would violate the Appendix E Health and Safety Requirements

3.3 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Location Requirements

4.1.1(a) Smoke alarms shall be installed:

4.1.1(a1) On a ceiling with insulation ≥R-11 whenever possible (Fig. 3-1)

4.1.1(a2) On an interior wall, when allowed by manufacturer, if insulated ceiling installation is not possible or

4.1.1(a3) On an exterior wall, when allowed by manufacturer, when no other suitable location is available

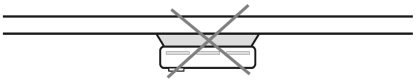


FIG. 3-1: AVOID INSTALLING SMOKE ALARMS ON CEILINGS WITH LESS THAN R-11 INSULATION

4.1.1 (b) The following locations require functioning smoke alarms:

4.1.1 (b1) Sleeping rooms/areas

- A properly functioning smoke alarm shall be present in each of the following locations (Fig. 3-2):
  - Inside each bedroom or separate area used for sleeping (den, family room, etc.) and
  - Outside each sleeping area in the immediate vicinity of the bedrooms (within 15')

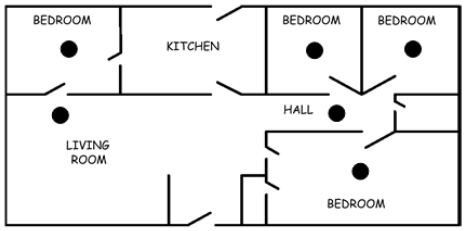


Fig. 3-2: Required Smoke Alarm Locations

4.1.1 (b2) Basements and multiple stories

- In addition to sleeping area protection, a smoke alarm shall be installed on each of the other levels (stories) of the dwelling, including basement and habitable attic (Fig. 3-3).
- In a split-level dwelling (less than one full story between levels) without a door between levels, a smoke alarm on the upper level satisfies the protection requirement for the adjacent lower level.
- Basement smoke alarm shall be installed on the ceiling near the entry to the stairs.

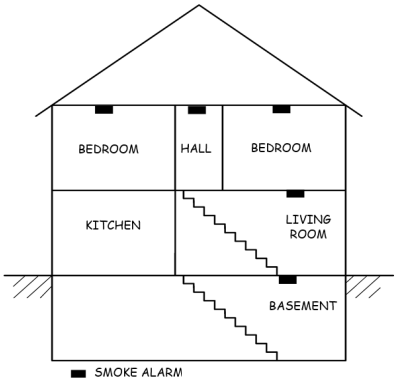


Fig. 3-3: Smoke Alarms in Two-Story House

4.1.1 (b3) Stairway locations

- When there is a stairway leading from one floor to another, an alarm is required at the top of the stairway.
- The alarm must be in a location where an intervening door or obstruction will not prevent rising smoke from reaching the alarm.
- When the alarm in the upstairs hallway (located within 15' of the upstairs bedrooms) can be placed at the top of the stairway, a second alarm is not required in that hallway.

4.1.1 (c) Mounting location by ceiling type

4.1.1 (c1) Flat ceiling

- The alarm shall be located as close as possible to the center of the room or hallway.
- An alarm on the ceiling shall be at least 4" from an adjacent wall.
- Wall installation shall have the top edge of the alarm 4"–12" below the ceiling.

4.1.1 (c2) Peaked (A-frame) ceiling

- The alarm shall be installed on the ceiling, near the peak, and located:
  - At least 4" vertically below the peak
  - Above a plane created by a 6' horizontal line extending ceiling-to-ceiling (Fig. 3-4)

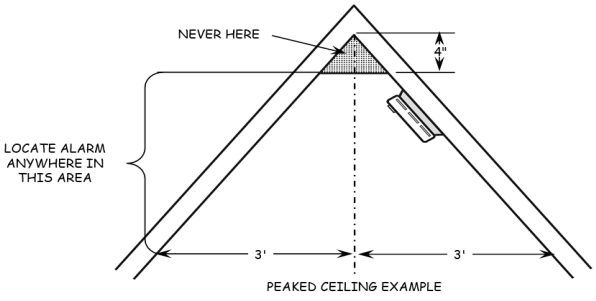


Fig. 3-4: Alarm Placement on Peaked Ceiling

4.1.1 (c3) Sloped (cathedral) ceiling

- The alarm shall be installed on the ceiling or wall and located:
  - At least 4" vertically below the peak
  - Above the plane created by a 3' horizontal line extending wall-to-ceiling (Fig. 3-5)

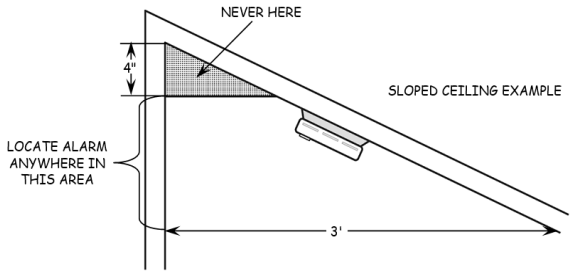


FIG. 3-5: ALARM PLACEMENT ON SLOPED CEILING

4.1.1 (c4) Coffered ceiling (tray-shaped with sunken panels)

- The alarm shall be installed on:
  - The highest portion of the ceiling or
  - The sloped portion of the ceiling within 12" vertically down from the highest point

4.1.1 (c5) Ceiling with joists or beams

- For a ceiling with beam depth less than 10% of the ceiling height, alarms shall be located on the bottom of a beam or as specified by the local jurisdiction.
- For a ceiling with greater beam depths, alarms shall be located in accordance with the National Fire Protection Association (NFPA) 72 §17.7.3.2.4 and the requirements of the local jurisdiction.

4.1.1 (d) Locations not allowed (Fig. 3-6)

4.1.1 (d1) In a garage or unconditioned space, unless it is used for sleeping

4.1.1 (d2) In a kitchen or insect-infested area

4.1.1 (d3) Over an electrical junction box (if the alarm is battery-powered)

4.1.1 (d4) Areas that:

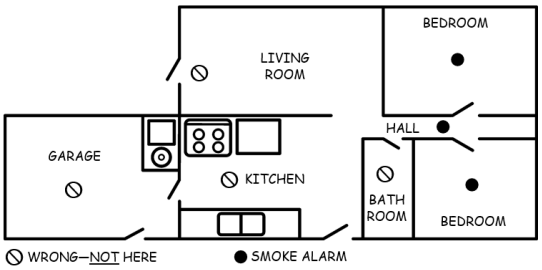


FIG. 3-6: CORRECT AND INCORRECT SMOKE ALARM LOCATIONS IN A SINGLE-STORY HOME

- Are excessively greasy, dusty, or humid
- Are behind furniture or draperies, near an inside corner, in an alcove or closet, etc.
- May get hotter than 100ºF or colder than 40ºF

4.1.2 Clearances (Ionization or Photoelectric Smoke Alarms)

4.1.2 (a) The alarm shall be

4.1.2 (a1) ≥1' horizontal distance from fluorescent lights because electric “noise” from the ballast may cause nuisance alarms.

4.1.2 (a2) ≥3' horizontal distance from all of the following:

- The door or opening to a moisture source (e.g., bathroom with bathtub or shower)
- A forced air return grille or supply register (and outside the direct flow from the register)
- The intake of a whole-house exhaust fan, including a mechanical ventilation unit
- The blades of a ceiling fan
- An openable window or entrance door
- A source of draft or air movement

4.1.2(a3) A horizontal distance of 20' from open combustion appliances (e.g., space and water heaters, cooking appliances)

- Exception: In areas where a 20' distance is not possible (e.g., modular/ mobile or small home), the smoke alarm shall be placed as far away as possible, but no closer than 10'.
  - When the distance from cooking appliances is less than 20', a photoelectric alarm must be installed.

4.1.3 Hardwired Smoke Alarms

4.1.3(a) New hardwired smoke alarm systems shall only be installed when required by the local jurisdiction (requires a program waiver).

4.1.3(b) Replacing an alarm in an existing hardwired smoke alarm system is allowed when replacement with a battery-powered alarm is not feasible or not allowed by the local jurisdiction.

4.1.3(c) Installation shall be performed by an qualified technician.

4.1.3(d) The circuit powering the alarm(s) shall be 24-hour, 120-volt alternating current (AC), 60 Hz, and shall not be controlled by a switch, dimmer, ground fault circuit interrupter (GCFI), or arc fault circuit interrupter.

4.1.3(e) The alarm shall be mounted over a standard wiring junction box.

4.1.4 Interconnected Alarms

4.1.4(a) If more than one hardwired alarm is installed, they shall be interconnected, if required by code.

4.1.4(b) If multiple interconnected hardwired smoke alarms are present and at least one within the group will be replaced:

4.1.4(b1) The replacement alarm shall be compatible with the existing interconnection system or

4.1.4(b2) All of the interconnected smoke alarms shall be replaced when required by the local jurisdiction. (This condition shall be documented in the client file.)

4.2. Installation Procedure

4.2.1 Existing Alarms

4.2.1(a) An existing alarm in an incorrect location shall be left in place.

4.2.1(a1) Batteries may be removed from an existing alarm to eliminate nuisance alarms if a new alarm is installed to provide adequate protection for that location.

4.2.2 Alarm Mounting

4.2.2(a) The mounting plate shall be secured to the ceiling or wall with at least two screws.

4.2.2(a1) Self-drilling or expansion anchors shall be used when screws do not penetrate solid wood.

4.2.2(b) If requested by a landlord or property owner, tamper-resistant mounting screws may be used for mounting.

4.2.2(c) Attach the alarm to the mounting plate.

4.2.3 Installation Date

4.2.3(a) The date of installation shall be written in permanent ink in the space provided on the alarm.

4.2.4 Replacement Date

4.2.4(a) The date by which the alarm should be replaced shall be written with permanent ink on the bottom or side of the alarm (as described by manufacturer).

4.2.4(b) The replacement date is the date of installation plus the expected life of the alarm.

4.2.4(c) The expected life is 10 years or as stated by the manufacturer, if greater.

4.2.5 Battery Compartment

4.2.5(a) The alarm manufacturer's original battery shall be used, and the battery compartment shall not be modified.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

5.1.1(a) In mobile homes that have ceilings with <R-11 insulation, smoke alarms shall only be installed on interior walls.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 Common area installation (e.g., in a boiler room, laundry room, hallway, etc. within the same thermal boundary as the dwelling units) is not allowed when only an individual unit in a multi-family building will be served (unless required by the local jurisdiction in conjunction with repair/replacement of a specific common area appliance).

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is a DOE Health & Safety (H&S) measure.

7.1.1(a) H&S measures must be installed when feasible. If the client refuses the measure, or it cannot be physically installed due to a dwelling condition, the dwelling must be deferred.

7.1.1(b) When installing this measure as part of the Audit path work scope, a Measure SIR and Dwelling SIR are not required.

7.1.1(c) When installing this measure as part of the Priority List (PL) path work scope, this measure is considered Mandatory, and the measure must be addressed before other PL measures are possible.

7.1.1(c1) Mandatory PL H&S measures include: carbon monoxide (CO) alarms, CVA venting, kitchen exhaust, lead-safe weatherization, LHR-H&S support, mechanical ventilation, and smoke alarms.

7.1.1(d) When this measure is paid for by LIHEAP, or is cost-shared with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/Priority List Protocol.

7.1.2 Install smoke alarms where the authority having jurisdiction requires them if alarms are not present or are inoperable.

7.1.3 Replace functional smoke alarms only when the existing alarm(s) are beyond the manufacturer's stated lifetime.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2(a) If required by local code, the excerpt from the local code must be included in the client file or provided to CSD upon request.

7.2.3 Mobile Home

7.2.3(a) Requirements for mobile homes are the same as those for single-family homes.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Each installed alarm shall be tested.

8.2. Client Education

8.2.1 All Alarm Installations

8.2.1(a) Both verbal and written instructions shall be provided regarding:

8.2.1(a1) Maintenance of the alarm (e.g., periodic cleaning, protection from being painted, battery replacement, etc.)

8.2.1(a2) Testing of the alarm

8.2.1(a3) Response to an activated alarm

8.2.1(a4) Response to failure signal (how to request replacement of the alarm should failure occur during the warranty period)

8.2.2 Tamper-Resistant Alarm Installations

8.2.2(a) The landlord or property owner will be provided a wrench for removal of tamper-resistant screws.

8.3. Clean-Up and Disposal Requirements

8.3.1 Packaging materials that include manufacturer's instructions or warranty information will be given to the customer.

8.3.2 All other installation and packaging materials shall be removed from the premises and disposed of properly.

8.3.3 Recycle smoke alarms and batteries according to local requirements.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 4 years

9.1.2 DOE: Not applicable to this measure

9.2 All alarms shall be:

9.2.1 Listed to Underwriters Laboratories (UL) 217

9.2.2 Single-purpose alarm (smoke only)

9.2.3 NFPA-approved photoelectric or ionization-type

9.2.4 On the state fire marshal's list of approved smoke alarms and have these features:

9.2.4(a) Date of manufacture on the alarm label

9.2.4(b) Test and hush buttons to check alarm electronics and temporarily silence unwanted nuisance alarms

9.2.4(c) End-of-life feature that indicates the alarm must be replaced

9.3 Battery-powered alarms shall have non-replaceable, non-removable batteries capable of powering the alarm for a minimum of 10 years.

9.4 Hardwired alarms:

9.4.1 Shall be 120-volt AC

9.4.2 Must have factory-installed lithium battery backup

9.4.3 Will be interconnectable when required, as described in Interconnected Alarms

9.4.3(a) When a hardwired, interconnected alarm is replaced, the replacement alarm shall be compatible with the existing system.

10. WARRANTY

10.1 Manufacturer—10 years

10.2 Contractor—1 year

4. Heating and Cooling

Table of Contents

1. MEASURE OBJECTIVES

1.1 Properly functioning heating and cooling appliances provide economical temperature control, reduce fuel consumption, and reduce pollution.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair/Install

2.1.1 The heating and/or cooling appliance provides primary heating and/or primary cooling for the dwelling unit and

2.1.2 Agency assessment identifies an operational or combustion appliance safety (CAS) issue (or inoperability) and a qualified/licensed technician determines that the heating and/or cooling appliance requires repair or replacement or

2.1.3 Absence of an operable heating and/or cooling appliance poses imminent harm to the safety and well-being of the occupants

2.2. Repair

2.2.1 Repair costs are <50% of replacement costs

2.2.2 Unsafe secondary units, including space heaters, must be repaired, removed or rendered inoperable, or deferral is required

2.3. Install

2.3.1 Repair costs are ≥50% of replacement costs or

2.3.2 Parts are obsolete and no longer available or

2.3.3 An energy audit shows replacement or energy efficiency upgrade is justified with a savings-to-investment ratio (SIR) ≥1.0

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1. Do Not Repair/Install

3.1.1 An operable primary heating/cooling source exists elsewhere in the dwelling

3.1.2 A repair can be completed by installing an electrically commutated motor (ECM) per Section 5 ECM Blower Motors

3.1.3 Accessibility or clearance requirements cannot be met, per Section 1 General Installation Guidelines, Attic & Crawlspace Accessibility Requirements or heating and cooling measure clearance requirements

3.1.4 Removal of the existing unit will create structural damage, dwelling siding is decayed or damaged, or the opening cannot properly support a new unit without substantial reconstruction

3.1.5 The installation location is unsafe and cannot be corrected per Section 1 General Installation Guidelines, Limited Home Repair

3.1.5(a) Unsafe locations may include, but are not limited to, those with pest or animal infestation, deteriorated framing members, environmental hazards, water damage, etc.

3.1.6 Ducted heating and/or cooling appliance has ducts that are disconnected, damaged, deteriorated, or abandoned, or do not provide adequate airflow and it is not feasible to bring the duct system into compliance with Section 8 Ducting Repair, Sealing, and Insulation

3.1.7 Repair/installation would violate the Appendix E Health & Safety Requirements

3.1.8 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 The policies in Appendix E Health and Safety Requirements, Identification of Appliance Issues shall apply to all heating and cooling repairs/replacements.

4.1.1(a) Before any heating or cooling system may be repaired/replaced, a qualified technician/licensed contractor must perform a diagnostic inspection to determine if the appliance is defective or requires repair.

4.1.1(b) It shall be determined if a cleaning and adjustment (appliance maintenance) would resolve an appliance performance or health and safety issue before the appliance is repaired or replaced.

4.1.1(c) Documentation justifying any appliance replacement with a cost comparison between replacement and repair must be maintained in the client file.

4.1.1(d) If permits are required for heating/cooling system work, and are coordinated and secured by Agency staff, they shall be billed to Other Program Cost Wages – Field Staff. The permit fees and any subcontractor cost associated with pulling of the permit shall be billed to the Permits line item under Assessments/Diagnostics.

4.1.2 Heat Sources

4.1.2(a) No home may be left without a safe primary heating system. If unable to meet this requirement, deferral is required.

4.1.2(b) When dwelling deferral is necessary, provide information to the client on the CSD 542 Deferral Form, describing conditions that must be met in order for weatherization to resume.

4.1.2(b1) A copy of this notification must also be placed in the client file.

4.1.3 Complete Design Before Installation

4.1.3(a) Before installation of any heating and/or cooling appliance, confirm that appliance location and support, appliance venting, combustion ventilation air (CVA), clearances, gas piping, electrical requirements, and all other feasibility criteria will be met for the replacement unit.

4.1.4 Primary Heating and/or Cooling Source

4.1.4(a) The primary heating and/or cooling source (one unit per dwelling) shall be repaired or replaced.

4.1.4(a1) Exception: Unsafe secondary units, including space heaters, must be repaired, removed, or rendered inoperable, or deferral is required.

4.1.4(a2) If there is an operable secondary system, a defective primary heating and/or cooling system may still be repaired/replaced.

4.1.4(a3) Primary heating and/or cooling appliances are defined as follows:

- The appliance that provides conditioned air for the dwelling's primary common living area (i.e., occupied during waking hours) or
- The unit relied upon most for heating and/or cooling by the client or
- The unit that provides conditioned air to the largest volume of living space or
- The unit with the largest heating/cooling capacity/output (British thermal units [Btuh] or tons)
  - Exception: Portable heaters shall not be considered a primary heat source.

4.1.4(b) A multi-story home may be constructed with a synchronized system (i.e., one forced air unit [FAU] and duct system per story, designed to run concurrently). Repair or replacement of components to the synchronized system may be allowed with approval of a CSD programmatic waiver only.

4.1.5 Audited Measures

4.1.5(a) When this measure will be installed under the Low Income Home Energy Assistance Program (LIHEAP) and an energy audit is performed, if the measure will be fully leveraged or co-funded it must comply with Appendix D Energy Audit/Priority List Protocol.

4.1.5(b) When this measure is paid for by LIHEAP, or is co-funded with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply.

4.1.6 HERS Rater Verification

4.1.6(a) In all climate zones, duct leakage must be verified by a HERS Rater when replacing a package unit, air handler, AC condenser, AC evaporator coil, heating coil, furnace heat exchanger, or more than 25' of ducts in unconditioned space in a conventional home.

4.1.7 Replace HVAC Appliances Before Duct Sealing

4.1.7(a) When an HVAC appliance will be replaced, the replacement must be completed before duct sealing work is done.

4.1.8 New HVAC Appliances

4.1.8(a) For new installations, all parts shall be new. Do not reuse existing parts.

4.1.8(a1) Exception: Vent components may be reused if in they are good condition and will meet current code requirements.

4.1.8(b) A damaged or defective appliance shall not be installed.

4.1.9 LIHEAP Weatherization Repair and Replacement Policy

4.1.9(a) An existing primary heating and/or cooling appliance that is "red tagged," has a qualifying CAS issue, or is inoperable may quality for repair or replacement.

4.1.9(b) Inoperable primary or non-existing heating and/or cooling may be installed or replaced if absence of the heating and/or cooling appliance poses imminent harm to the safety and well being of the occupants.

4.1.10 Energy Crisis Intervention Program (ECIP) Repair and Replacement Policy

4.1.10(a) Appliance Repair/Replacement Criteria

4.1.10(a1) The repair or replacement of a heating and/or cooling appliance qualifies under ECIP if it has a hazardous condition that poses a direct risk of fire or dangerous indoor air quality, including:

- High carbon monoxide (CO) levels, gas leak, or cracked or defective heat exchanger per Appendix A Combustion Appliance Safety Protocol
- A condition that violates a significant state or local building code including improper clearances, inadequate combustion ventilation air, or non-conforming location and/or venting
- A refrigerant leak
- A condition that violates a significant state or local building code, e.g., a wood-burning stove in a mobile home that draws combustion air from the living space
- Another hazardous condition, upon the preapproval of CSD

4.1.10(b) Heating and/or Cooling Hardship Cases:

4.1.10(b1) The replacement of a heating and/or cooling appliance qualifies under ECIP if using the existing appliance creates a hardship, including:

- A wood-burning stove in the home of an elderly or disabled occupant who cannot physically handle the fuel
- There is no heating or cooling appliance present

4.1.10(c) Non-existent or Inoperable Appliances

4.1.10(c1) A non-existent or wholly inoperable heating and/or cooling appliance may be repaired, replaced, or installed when the applicant meets at least one of the following requirements:

- An occupant has a qualifying "medical condition" that requires temperature control. The condition must be verified by a doctor's recommendation or other objective evidence gathered at the time of application.
- An occupant is a member of a vulnerable population as identified in the LIHEAP Local Plan and the absence of heating and/or cooling creates an emergency health and safety need.

4.1.11 Change of Heating/Cooling Type

4.1.11(a) Replacement of a heating or cooling system with a different type of unit (e.g., a ductless mini-split heat pump or a unitary system) shall be allowed under the following conditions:

4.1.11(a1) When an energy audit is conducted (with the SIR ≥1.0) per Appendix D Energy Audit/Priority List Protocol or

4.1.11(a2) By approved CSD waiver

4.1.12 Fuel Switching

4.1.12(a) Fuel conversion is allowed when an energy audit is conducted (with the SIR ≥1.0) per Appendix D Energy Audit/Priority List Protocol.

4.1.12(a1) For more detail, refer to the Section 1 General Installation Guidelines, Fuel Switching Policy.

4.1.12(b) An unused appliance gas line valve shall be capped.

4.1.13 Accessibility and Clearances

4.1.13(a) The appliance shall meet the clearance requirements described in the Appendix A Combustion Appliance Safety Protocol.

4.1.13(b) Equipment shall be accessible for inspection, service, repair, and replacement without removing permanent construction.

4.1.13(c) Heating, ventilation, and air conditioning (HVAC) units shall not be obstructed by landscaping, structures, etc.

4.1.13(d) If located in an attic or crawlspace, the heating/cooling unit shall meet the clearance requirements identified in Section 1 General Installation Guidelines, Attic and Crawlspace Accessibility.

4.1.13(e) Egress requirements

4.1.13(e1) See Section 1 General Installation Guidelines, Window Egress (Conventional Homes).

4.1.14 Electrical Supply and Grounding

4.1.14(a) If an electrical upgrade is required beyond the standard scope of HVAC installation, electrical work shall be performed by a licensed electrician.

4.1.14(b) The electrical outlet and circuit must:

4.1.14(b1) Comply with Section 1 General Installation Guidelines, Electrical Guidelines and Section 1 General Installation Guidelines, Grounding Guidelines, manufacturer's requirements, and local code

4.1.14(b2) Have adequate current capacity, be grounded, and have the correct polarity

4.1.14(b3) Have no evidence of hazardous conditions (e.g., charring, frayed insulation, loose wires or box, etc.)

4.1.14(b4) Have overcurrent protection (i.e., fuse or breaker)

4.1.14(b5) Be on the supply side of the disconnect switch

4.1.14(b6) Have a receptacle that:

- Conforms to manufacturer's instructions and local code
- Matches the plug on the unit's power cord

- Be located within sight of the equipment
- Be on the roof, adjacent to the equipment (if the unit is roof-mounted)

4.1.14 (c) With outlets of ≤120 volts, plug the unit into a dedicated receptacle when required by the manufacturer.

4.1.14 (d) For outlets of ≥208 volts, the unit must have a dedicated receptacle outlet.

4.1.14 (e) If allowed per the appliance manufacturer's instructions, an extension cord may be used.

4.1.14 (e1) Cord specifications must match or exceed manufacturer's instructions.

4.1.14 (e2) Cords shall not be draped over a countertop or furnishings in a manner that:

- Allows children to reach and pull on them
- Creates a tripping hazard

4.1.14 (f) Additional electrical requirements for central air conditioner (AC), heat pump, and furnace

4.1.14 (f1) Voltage drop shall be within manufacturer specifications.

4.1.14 (f2) Blower amperage shall not exceed manufacturer full load amperage.

4.1.14 (f3) Compressor amperage shall not exceed manufacturer's specification.

4.1.14 (f4) Blower compartment safety switch operation will be verified.

4.1.14 (f5) Emergency heat circuit functions will be verified for heat pumps.

4.1.14 (f6) Branch circuit protection

- AC equipment shall be provided with overcurrent protection and a means of disconnecting in accordance with the and local code.
- The overcurrent protection device shall be in compliance with the AC equipment nameplate.

4.1.14 (f7) Service disconnect

- The unit shall be connected to a circuit with a service disconnect (Fig. 4-1) and shall be:
  - Located within sight of, and readily accessible from, the AC equipment, or as required by local code
  - Installed on or within the AC equipment

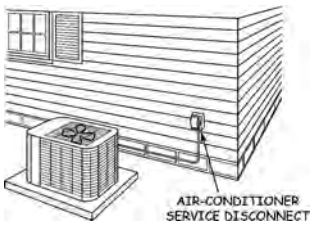


FIG. 4-1: SERVICE DISCONNECT

4.1.15 Unit Protection

4.1.15 (a) Units subject to mechanical damage shall be protected.

4.1.15 (b) Unit shall be attached to base with seismic straps, when required by local code.

4.1.15 (c) When an AC is repaired or replaced, locking caps shall be installed on accessible refrigerant service valves.

4.1.16 Refrigerant-Based Systems

4.1.16 (a) Refrigerant-carrying components (compressor and coils) shall only be moved, adjusted, repaired, or charged by a qualified technician.

4.1.16 (b) Refrigerant lines shall:

4.1.16 (b1) Be properly sized

4.1.16 (b2) Provide the rated seasonal energy efficiency ratio for the combination condenser and evaporator coil match, per the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) directory

4.1.16 (b3) Be routed, supported, and secured to house in a manner that protects the line from damage by workers or occupants

4.1.16 (b4) Be installed without kinks, crimps, or excessive bends

4.1.16 (b5) Be insulated and installed with ultraviolet-resistant, code-approved line set protection

4.1.16(c) Refrigerant charging

4.1.16(c1) The refrigerant system shall be properly charged using the methods specified by Title 24 for home energy rating system (HERS) verification.

4.1.16(c2) Non-condensable gas and moisture shall be bled from the refrigerant circuit using a vacuum pump.

4.1.16(c3) In climate zones 2 and 8–15, when a new or replacement AC or heat pump is installed, or when the condenser coil or a refrigerant-containing component is installed, the correct refrigerant charge must be measured by the installer and verified by a HERS Rater.

4.1.16(d) Refrigerant recovery

4.1.16(d1) When refrigerant lines will be disconnected, refrigerant will be recovered in accordance with Environmental Protection Agency (EPA) regulation 40 Code of Federal Regulations (CFR) 608 by a licensed contractor.

4.1.17 Duct-Based Systems

4.1.17(a) Title 24 verification by a HERS Rater

4.1.17(a1) Duct leakage testing

- In all climate zones, duct leakage must be verified by a HERS Rater when replacing a package unit, air handler, AC condenser, AC evaporator coil, heating coil, furnace heat exchanger, or more than 25' of ducts in unconditioned space.

4.1.17(a2) Minimum airflow and maximum fan wattage

- In all climate zones, when an entirely new space-conditioning system is installed (all equipment and ducts replaced) or 75% of the duct system is replaced, minimum airflow and maximum fan watt draw must be verified.

4.1.18 Recall Considerations

4.1.18(a) A current list of recalled heating and/or cooling appliances is available at https://www.cpsc.gov/Recalls/.

4.1.18(b) Certain nitrogen oxide (NOx) rod furnaces have been identified as being dangerous, and a list of the recalled units is provided in Appendix A Combustion Appliance Safety Protocol.

4.1.18(c) An attempt must be made to have the manufacturer pay for repair or replacement of the potentially dangerous appliance. If reimbursement from the manufacturer for a recalled appliance is not possible, a CSD waiver shall be requested.

4.1.18(d) When an FAU is repaired or replaced by the manufacturer at no cost, the weatherization contractor shall be reimbursed only for costs actually incurred, generally limited to ancillary components and installation labor.

4.1.19 Roof-Mount Appliances

4.1.19(a) The roof and support frame or curb shall be structurally adequate to properly support the installed equipment (Fig. 4-2).

4.1.19(b) Curb base and exposed roof penetrations shall be properly installed, flashed, and sealed watertight.

4.1.19(c) Roofing materials shall be in good condition and not in need of repair or replacement.

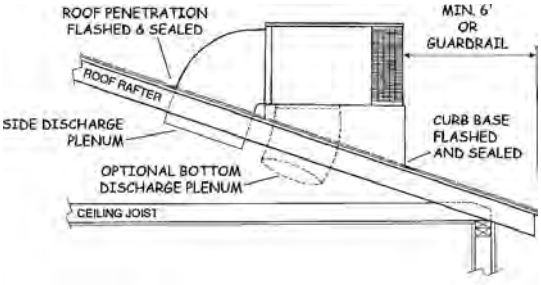


FIG. 4-2: ROOF-MOUNT APPLIANCES

4.1.20 Repair of Roof, Walls, and Floors Following Heating/Cooling Unit Installation

4.1.20(a) Any holes or damage to the roof/wall/floor resulting from installation or removal of an HVAC unit shall be repaired to:

4.1.20(a1) Match the plane of the adjacent material

4.1.20(a2) Match the texture of, and blend with, surrounding surfaces

4.1.21 Heating and Cooling Measures Directory

- Central AC/Central Heat Pump
- Ductless Mini-Split Heat Pump
- Wall/Window Air Conditioner
- Evaporative Cooling
- Central Furnace
- Floor, Wall, and Freestanding Furnace
- Wood Stove/Fireplace Insert
- Appliance Enclosure, Platform, and Plenum
- Mobile Home Central AC/Heat Pump
- Mobile Home Evaporative Cooling
- Mobile Home Central Furnace
- Mobile Home Floor/Wall and Freestanding Furnace
- Mobile Home Wood Stove/Fireplace Insert

4.1.22 Table 4-1 provides a reference for specific measures and activities.

TABLE 4-1: HVAC SUPPORTING ACTIVITY DIRECTORY

Supporting Activity	Technical Reference Manual Section
Access and Service Space	• Section 1 General Installation Guidelines, Attic & Crawlspace Accessibility
	• Accessibility and Clearances
	• Central AC/Central Heat Pump, Clearances
	• Wall/Window Air Conditioner, Location
	• Evaporative Cooling, Location
	• Appliance Enclosure, Platform, and Plenum
Air Filter Installation	• Section 10 Air Filters
	• Air filter installation
Appliance Electrical System Wiring	• Section 1 General Installation Guidelines, Electrical Guidelines
	• Section 1 General Installation Guidelines, Grounding Guidelines
	• Electrical Supply and Grounding
	• Window/wall electrical requirements
	• Roof-mount units, Wall-mounted Controls
	• Roof-mount electrical requirements
	• Mobile Home Central AC/Heat Pump, Electrical Wiring, Grounding, and Accessibility

TABLE 4-1: HVAC SUPPORTING ACTIVITY DIRECTORY

Supporting Activity	Technical Reference Manual Section
Appliance Flue Vent Systems	• Appendix A Combustion Appliance Safety Protocol
	• Wall/Window Air Conditioner, Exterior clearance
	• Evaporative Cooling, Setbacks and clearances
	• Central Furnace, Appliance vent system installation
	• Floor, Wall, and Freestanding Furnace, Venting
	• Floor, Wall, and Freestanding Furnace, Freestanding furnace
	• Mobile Home Evaporative Cooling, Window/wall exterior clearances
	• Mobile Home Evaporative Cooling, Roof-mount clearances
	• Mobile Home Central Furnace, Appliance Vent System
CVA	• Appendix A Combustion Appliance Safety Protocol
	• Central Furnace, CVA
	• Floor, Wall, and Freestanding Furnace, CVA
	• Wood Stove/Fireplace Insert, CVA
	• Appliance Enclosure, Platform, and Plenum, Enclosures
	• Mobile Home Central Furnace, CVA
	• Mobile Home Wood Stove/Fireplace Insert, CVA
Ducting (Return and Supply)	• Section 8 Ducting Repair, Sealing, and Insulation
	• Duct-Based Systems
	• Evaporative Cooling, Cooler ducting
	• Evaporative Cooling, Roof-mount barometric damper
	• Central Furnace, Air distribution (duct) system
	• Appliance Enclosure, Platform, and Plenum
	• Mobile Home, Roof jack and duct start collar
Fuel Switching	• Section 1 General Installation Guidelines, Fuel Switching Policy
Gas Lines, Fittings, and Valves	• Appendix A Combustion Appliance Safety Protocol
	• Central Furnace, Gas line and fittings installation
	• Floor/Wall/Freestanding Furnace, Gas piping and valves
	• Floor/Wall/Freestanding Furnace, Gas control valve
Thermostats	• Section 7 Thermostats—Smart, Programmable, and Manual
	• Central AC/Central Heat Pump, Thermostats and controls
	• Central AC/Central Heat Pump, Heat pump controls
	• Central Furnace, Thermostats and controls
	• Floor, Wall, and Freestanding Furnace, Thermostat
Upgrade ECM Blower Motor	• Section 5 ECM Blower Motors
Upgrade Efficient Fan Controller	• Section 6 Efficient Fan Controllers

TABLE 4-1: HVAC SUPPORTING ACTIVITY DIRECTORY

Supporting Activity	Technical Reference Manual Section
Vent Covers	• Section 32 Infiltration Reduction
	• Wall/Window Air Conditioner, Winter protection/closure
	• Evaporative Cooling, Window/wall winter protection
	• Evaporative Cooling, Roof-mount units

4.2. Central AC/Central Heat Pump

4.2.1 General Requirements

4.2.1(a) None

4.2.2 Procedure

4.2.2(a) Repair

4.2.2(a1) A tune-up may be performed on an existing package unit or split system when a qualified technician identifies an operational issue that will be resolved by the tune-up procedure as described below.

- System verification
  - Confirm the temperature of the supply air (unit must be cooling) and the temperature of the suction line (must be cold).
- Unit set-up
  - All register dampers shall be open, and duct dampers and zone dampers shall be correctly positioned.
- Air handler
  - The air handler blower wheel shall be brushed and cleaned.
  - Visually inspect the capacitors and wiring.
  - Check the motor bearings for wear and oil them as needed (Fig. 4-3).
  - With the blower operating at high speed, check the blower motor amperage for compliance with the manufacturer's specified range.
  - Seal (e.g., with cork tape) air leaks at plumbing or wiring penetrations.

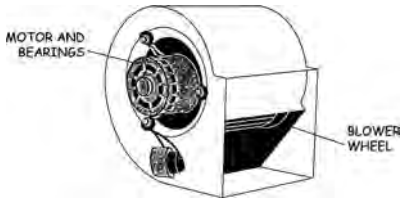


FIG. 4-3: AIR HANDLER BLOWER

- Air filter
  - Clean or replace dirty, defective, or missing AC filters per Section 10 Air Filters (Fig. 4-4).
    - Exception: Electrostatic filters may be cleaned (but shall not be replaced).
- Evaporator (indoor coil)
  - The evaporator coil will be checked and cleaned when it can be accessed through removable panels.
    - The coil will be cleaned using a coil brush, vacuum, and/or air pressure.
    - If dirt remains, use a water-based, non-acid, non-corrosive coil cleaning spray or foam applied per product instructions.
    - Water may be sprayed on coils to clean or rinse them, with care taken to avoid wetting the electronic controls or motor.
    - Wet coils must be dry before operating the unit.

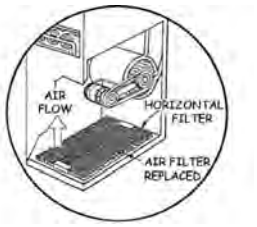


FIG. 4-4: AIR HANDLER FILTER

        - Accessible coil fins will be checked for damage and combed as needed using a fin comb that matches the fins-per-inch spacing.
    - The condensate drain system (including pump, when present) will be checked and cleaned as needed (Fig. 4-5).
    - Ensure access panels are closed and sealed with Underwriters Laboratories (UL) 181A/B or B-FX metallic tape with non-butyl adhesive.

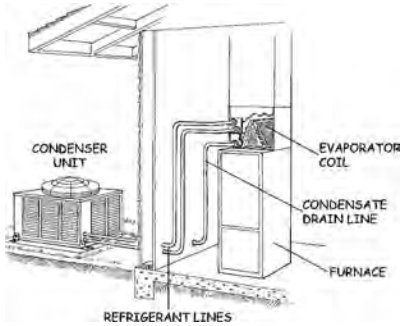


FIG. 4-5: CHECK AND CLEAN CONDENSATE DRAIN SYSTEM

- Condenser
    - Clean the inside of the unit and fan blades with vacuum brush attachment.
    - Check the condenser coil and clean as described above for the evaporator coil.
    - Inspect compressor contact points, compressor terminal block, and capacitors to ensure all connections are proper and tight.
    - Check compressor and condenser amperage with unit operating in AC mode (Fig. 4-6).
    - Check fan motor bearings for wear, and oil as needed.

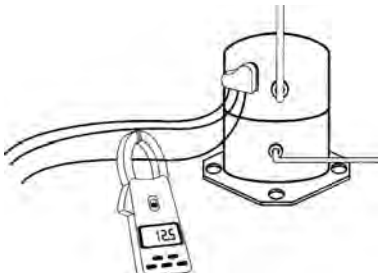


FIG. 4-6: CHECKING COMPRESSOR AMPERAGE

- All equipment integrity
    - Tighten loose items (e.g., screws, bolts, panels, etc.).
    - Repair or replace missing or damaged components critical to proper operation.
- Return and supply ducts
    - Duct testing shall be conducted in accordance with Appendix B Duct Leakage Testing Protocol.
    - Duct sealing shall be conducted in accordance with Section 8 Ducting Repair, Sealing, and Insulation.
- Thermostats and controls
    - The anticipator shall be correctly set, when applicable.
    - Wiring connections must be correct and tight.
    - The thermostat shall be level and securely installed.
    - Adjust the AC controls, including the limit switch and blower fan switch, to operate in accordance with the manufacturer's specifications.
    - Power switches must function properly, including:
        - The blower access lockout/safety switch
        - The switch controlling power to the unit (disconnect)
        - The blower speed control switch
- Airflow assessment
    - Airflow through the indoor coil shall meet manufacturer's specifications.
- Refrigerant charge
    - Leak detection, air flow, and refrigerant line inspection will be checked and repaired to determine need for refrigerant charge

- After determining airflow, the proper refrigerant charge metering procedure shall be used:
  - Superheat—Fixed-orifice metering device
  - Sub-cooling—Thermal expansion valve metering device
  - Other manufacturer recommended methods
  - Weigh-in
- The outdoor temperature shall be at or above the minimum required for the diagnostic procedure used (e.g., 55°F for superheat and sub-cooling).
- If the outdoor temperature is <55°F, a manufacturer-approved "weigh-in" procedure must be utilized.

4.2.2 (b) Install

4.2.2 (b1) Location

- Roof-mount
  - Refer to Roof-Mount Appliances.
  - Roofing materials shall be in good condition and not in need of repair or replacement.
  - The roof and support frame or curb shall be structurally adequate to properly support the installed equipment.
  - Curb base and exposed roof penetrations shall be properly installed, flashed, and sealed watertight.
- Ground-mount
  - The unit shall rest on concrete or other approved base extending at least 3" above the adjoining ground level (Fig. 4-7).
  - The condenser unit labels shall be visible.
- Clearances
  - Minimum clearance between AC equipment or electrical panels and the adjacent structure/wall/obstruction shall be:
    - 30" on side(s) containing service access panels and
    - 12" on all other sides or
  - 5' from clothes dryer moisture exhaust
- Overhead clearance shall be provided.

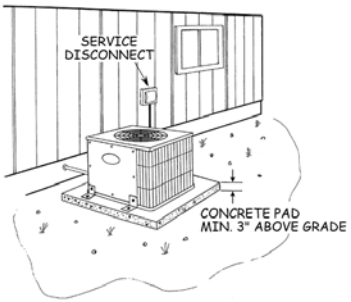


Fig. 4-7: Ground-Mount Base

4.2.2 (b2) Evaporator coil replacement

- An evaporator coil shall be installed that is verified to be a rated match with the condenser unit, as listed in the current AHRI directory (Fig. 4-8).
- An access panel shall be provided for coil cleaning.
- The evaporator coil unit labels shall be visible.
- Airflow through the coil shall be adequate to meet the manufacturer's specifications.

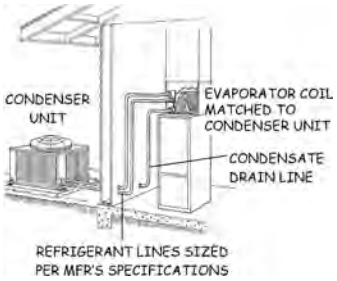


Fig. 4-8: Condenser Unit Compatible with Evaporator Coil

4.2.2 (b3) After installation, the condenser unit and evaporator coil shall be verified to function properly.

4.2.2 (b4) Condensate drain

- A condensate drain line shall be installed on evaporator coils and heat pump units.
- Condensate shall be drained to an approved place of disposal.
- Drain line shall maintain a minimum horizontal slope not less than ⅛" vertical in 12" horizontal (1% slope) in the direction of discharge.
- An indoor unit condensate drain shall be insulated, be covered with a vapor barrier, and slope downward to a code-approved connection in the drainage system or to a suitable exterior drain site away from walking areas.
- Condensate shall not discharge into a street, alley, or other area where it would cause a nuisance.
- Connections in the condensate drain system shall be watertight.
- The end of the drain line shall be visible
- Condensate drain pumps shall be installed when condensate cannot be drained by gravity.
  - A power source for the pump shall be installed if one is not present.
  - Operation and drainage of pump shall be verified.
- Vents and traps shall be installed on condensate drain lines.
  - The trap supplied with the equipment shall be used.
- Roof-mounted units
  - Run the condensate drain line to a nearby gutter, when present, or in accordance with local code.
  - Paint the line to resist ultraviolet (UV) degradation if polyvinyl chloride (PVC) is used.
- When overflow could damage finished surfaces, install:
  - A float switch in the primary condensate drain (for upflow systems) or
  - A secondary drain pan and float switch
    - All secondary drain pans will have a float switch and be drained away through a drainline.

4.2.2 (b5) Air distribution (duct) system

- See Section 8 Ducting Repair, Sealing, and Insulation.

4.2.2 (b6) Preparation of platform returns and plenums

- See Appliance Enclosure, Platform, and Plenum.

4.2.2 (b7) Heat pump controls

- Unless a properly functioning thermostat is present, a new thermostat shall be installed in accordance with Section 7 Thermostats—Smart, Programmable, and Manual.
- A thermostat with supplementary heat lockout that can interface with an outdoor temperature sensor will be selected and set according to manufacturer requirements.

4.2.2 (b8) Air filters

- All new AC units installed shall be fitted with new air filters.
- Unframed filters shall be properly supported to prevent them being drawn into the air handler, as prescribed in Section 10 Air Filters.

4.3. Ductless Mini-Split Heat Pump

4.3.1 General Requirements

4.3.1 (a) The client shall be allowed to select a recessed or flush-mount system.

4.3.2 Procedure

4.3.2(a) Repair

4.3.2(a1) A tune-up for an existing ductless mini-split system may be performed by qualified technicians using the procedure from Central AC/Central Heat Pump and as recommended by the manufacturer.

4.3.2(b) Install

4.3.2(b1) Indoor unit

- The indoor unit location shall:
  - Be structurally sound and capable of supporting the weight of the unit
  - Provide maximum coverage of the living space for conditioned airflow
  - Not be exposed to direct sunlight and sources of heat
  - Provide the required clearances to facilitate installation

4.3.2(b2) Outdoor unit

- The outdoor unit location shall:
  - Be a minimum of 5' from clothes dryer moisture exhaust termination.
  - Provide adequate shade, drainage, airflow, and clearances
  - Located to avoid water run-off from the roof
  - Be level and secured to a solid pad a minimum of 3" above the adjoining ground level
  - Be placed on adjustable risers or a wall-mount bracket when debris or snow build-up could impede drainage under the unit.
  - Have a pan heater in cold locations.

4.3.2(b3) Condensate drain (see Condensate drain).

4.3.2(b4) The thermostat shall sense the temperature at the controller, not in the return path.

4.4. Wall/Window Air Conditioner

4.4.1 General Requirements

4.4.1(a) Clearances

4.4.1(a1) Interior clearance (Fig. 4-9)

- The wall-mount unit air discharge outlet should be located a minimum of 3' above the floor unless mounted below a window or in an existing location that is lower.

4.4.1(a2) Exterior clearance (Fig. 4-10)

- The exterior portion of the unit should be located a minimum of 24" above grade.
- There should be at least 12" between the AC and adjacent walkway or wall.
- The unit's air intake should be located:
  - At least 10' away from or 3' below combustion appliance vent terminations.
  - At least 10' from:
    - Clothes dryer moisture exhaust termination
    - Plumbing vent terminations
    - Exhaust fan vent termination
  - At least 3' from the AC inlet to the gas meter.

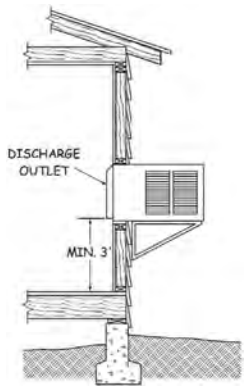


FIG. 4-9: WINDOW/WALL AC MINIMUM INTERIOR CLEARANCES

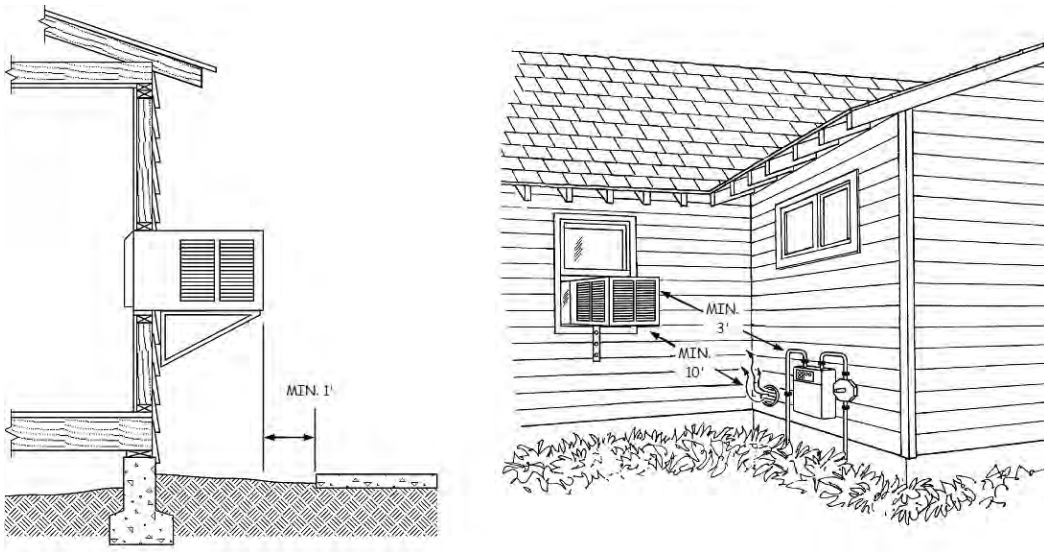


FIG. 4-10: WINDOW/WALL AC MINIMUM EXTERIOR CLEARANCES

4.4.1 (b) Condensate drain

4.4.1 (b1) Condensate drain shall slope downward to a suitable drain site away from the dwelling wall.

4.4.1 (b2) A drain hose/line is required when:

- The AC is located above first floor or
- Condensate will drain onto a patio or walking surface and create puddles

4.4.1 (c) Winter protection/closure

4.4.1 (c1) The installed unit must have interior or exterior closure system (to prevent infiltration in the winter season) (Fig. 4-11), per Section 32 Infiltration Reduction, Vent Covers.

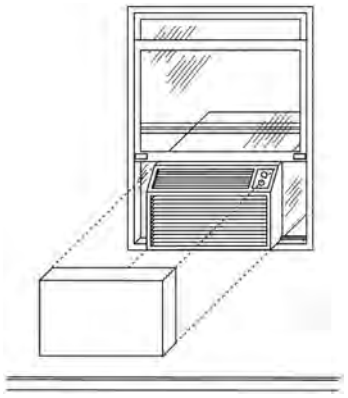


FIG. 4-11: INTERIOR COVER FOR DISCHARGE OPENING

4.4.2 Procedure

4.4.2 (a) Repair

4.4.2 (a1) American National Standards Institute (ANSI)/Air Conditioning Contractors of America (ACCA) protocols will be used when conducting repair-related maintenance.

4.4.2 (a2) Air filter

- Replace damaged/defective filters.
- Clean washable air filters with detergent and water. Allow to dry before reinstalling.
  - For other filter types, follow the guidelines in Section 10 Air Filters.

4.4.2 (a3) Coil care and cleaning

- See Evaporator (indoor coil) and Condenser.

4.4.2 (a4) Drain port cleaning

- With a small wire brush, clean:
  - The condensate drain(s)
  - The drain port(s) on the evaporator side in conjunction with the coil cleaning
  - The condenser side drain port(s), if present

4.4.2 (a5) Repair or replace defective gaskets and caulking.

4.4.2 (a6) Appliance troubleshooting

- Noisy fan:
  - Tighten the fan blades, motor, and housing bolts if loose.
  - If the fan is damaged, crooked, broken, replace it with the same model.
  - Lubricate fan motor oil ports.
- Inoperable fan:
  - Use a voltmeter to troubleshoot.
- Removal of the fan motor:
  - Motor replacement must be performed by a qualified contractor or technician
- Thermostat or controls malfunction and/or the AC cycles on and off frequently:
  - Ensure the thermostat sensor behind the front grille is positioned near but not touching the evaporator (inside) coil. Adjust it if needed.
  - The front panel shall not be obstructed.
  - Repeat the coil cleaning procedure Evaporator (indoor coil) and Condenser.
  - If performance does not improve, a qualified technician should check for a refrigerant leak and repair and properly recharge the system.
- Unit is inoperable or the AC will not turn on:
  - Check for a tripped breaker or blown fuse.

4.4.2 (b) Install

4.4.2 (b1) Location

- Install the unit only in a window or wall opening that allows:
  - Free air circulation, free of obstruction
  - Stable and safe installation
  - Access for inspection and service without removing permanent construction

4.4.2 (b2) Window-mount units

- Place the AC in the center of the window opening (side-to-side), if feasible (Fig. 4-12).
- Install transparent, permanent window panels to completely fill empty spaces greater than 12" wide.
- Seal the panels in place.
- For installation in an alternate window type, manufacturer's instructions shall be followed.

4.4.2 (b3) Wall-mount units (Fig. 4-13)

- The wall must be structurally sound and able to support the unit's weight and vibration.
- Enlarge or reduce the hole to meet manufacturer's hole size and clearance specifications.
- The opening shall be framed with structural members.

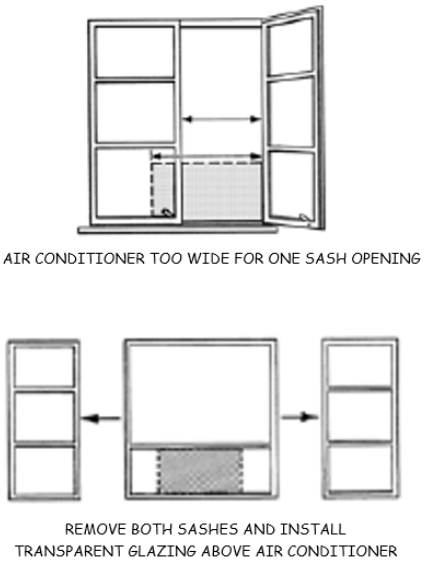


FIG. 4-12: WINDOW-MOUNT AC UNITS

- Neatly patch and trim interior and exterior sheathing with all exposed wood primed and painted to match adjacent trim appearance. Openings in brick veneer and block walls should have:
  - Lintel and flashing installed above the opening when required
  - Flashing (drip rail) installed below the unit
- Seal the unit in place.

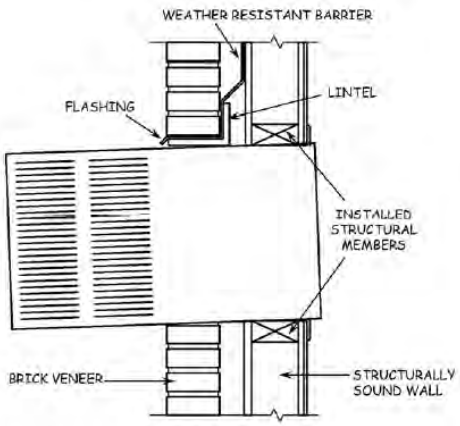


FIG. 4-13: WALL-MOUNT AC UNTS

4.4.2 (b4) Unit supports

- Brace supports should be anchored with non-corrosive screws to solid wood.
- All brace support materials must be metal.

4.4.2 (b5) Ensure the unit is level and plumb

- Front-to-back: The unit should be sloped one half bubble downward to the outside for condensate drainage.

4.5. Evaporative Cooling

4.5.1 General Requirements

4.5.1 (a) Unit shall be installed in a central location in the dwelling. Installation shall be allowed in a bedroom only when a medical or other special condition is granted by program waiver and documented in the client file.

4.5.1 (b) Adequate exhaust ventilation must be available.

4.5.1 (c) Setbacks and clearances

4.5.1 (c1) There shall be at least 3' between the cooler and the adjacent fence or wall, unless a shorter distance is allowed by local code or recommended by the manufacturer (Fig. 4-14).

4.5.1 (c2) The unit shall not extend over a sidewalk, and shall be set back at least 12" or as prescribed by local code.

4.5.1 (c3) Cooler inlet shall be at least:

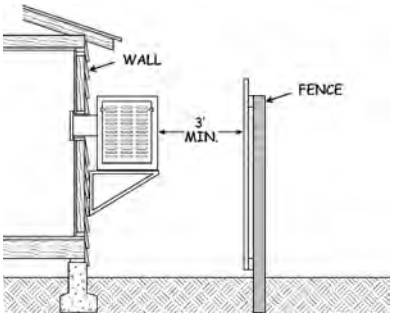


FIG. 4-14: CLEARANCE FROM FENCE OR WALL

- 10' from or 3' below a combustion appliance vent termination, gas vent pipe, or solid-fuel chimney
- 10' from a bathroom or kitchen exhaust, clothes dryer exhaust, plumbing vent, vehicle exhaust source, or other source of toxic contamination
- 3' from an attic vent or gas meter set assembly

4.5.1 (c4) A minimum of 24" clearance is required on all sides of the unit for maintenance.

4.5.1 (d) Exhaust ventilation

4.5.1 (d1) Adequate exhaust ventilation shall be provided, which may consist of one or more of the following means:

- Screened window or door openings as shown in Table 4-2
- Ceiling-mounted exhaust vents or pressure relief dampers that exhaust cooled air through the attic
  - Attic net free ventilation area (NFVA) must equal or exceed the total NFVA of the ceiling vents (Table 4-2).

- Vents must close completely to block backdraft/infiltration when the cooler is off.
- Vents must be equipped with a positive closure mechanism that is automatically activated by high heat.
- Ceiling vents may not be used when the attic contains open combustion appliances.
- Ceiling vents may be used as the sole exhaust path only if the total NFVA or cu. ft. per minute (CFM) capacity of the vents equals or exceeds:
  - The NFVA/capacity recommended by the vent manufacturer or
  - The minimum NFVA shown under “Attic Exhaust Minimum NFVA” in Table 4-2

TABLE 4-2: EVAPORATIVE COOLER EXHAUST OPENINGS

Cooler Capacity (Airflow in CFM)	Window & Door Exhaust [1] Minimum Screened Openings	Attic Exhaust [2, 3] Minimum NFVA
3000	6 sq. ft.	4.0 sq. ft.
3500	7 sq. ft.	4.7 sq. ft.
4000	8 sq. ft.	5.3 sq. ft.
4500	9 sq. ft.	6.0 sq. ft.
5000	10 sq. ft.	6.7 sq. ft.
5500	11 sq. ft.	7.3 sq. ft.
6000	12 sq. ft.	8.0 sq. ft.
6500	13 sq. ft.	8.7 sq. ft.

[1] Values shown assume #16 mesh insect screening will be present.
[2] Values are calculated using the formula: Cooler capacity CFM ÷ 750 = Min. exhaust NFVA.
[3] See Section 40 Attic Ventilation, Tables 40-1 through 40-22.

4.5.1(e) Window/wall winter protection

4.5.1(e1) The installed unit must have interior or exterior closure system (to prevent infiltration in the winter season), per Section 32 Infiltration Reduction, Vent Covers.

4.5.2 Procedure

4.5.2(a) Repair

4.5.2(a1) The following items shall be checked and repaired or replaced when defective.

- Inlets and outlets shall be unobstructed.
- Platform/attachment repair
  - Check the existing platform and attachment to ensure that the following requirements are met:
    - The cooler is level and securely attached to the mounting assembly.
    - The mounting anchors are the correct size and are properly installed.
    - The unit is installed in a manner that will safely support the operating weight (cooler plus water).
- Blower motor
  - Verify that electrical connections are proper
  - Verify that the motor is safely and securely mounted and all nuts and bolts are tight.
  - Check the motor bearing for proper lubrication (Fig. 4-15).

- Replace the blower motor if it is frozen or if the shaft does not spin freely.
  - Replacement motors shall be two-speed.
  - Exception: If the existing motor is single-speed, the replacement may be single-speed.

FIG. 4-15: LUBRICATE MOTOR BEARINGS

- Pulleys (Fig. 4-16)
  - Ensure that:
    - The set screws are tight and the pulley is secure on the shaft
    - The motor pulley and blower pulley are aligned to within ¼".
    - The pulley rim is perpendicular to the motor shaft
  - Replace bent blower pulleys.
  - Replace a bent motor pulley with an adjustable pulley for controlling the motor amperage and the speed of the blower.
    - Exception: A fixed pitch pulley may be installed in a window- or wall-mount cooler if the pulley and motor size/speed match the original equipment.

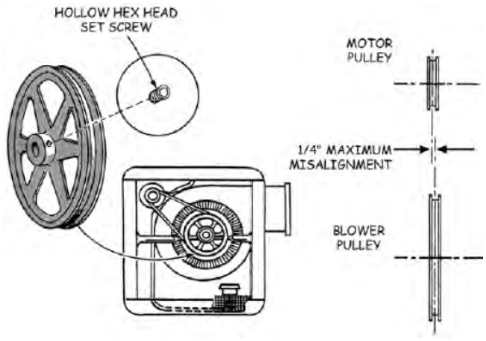


FIG. 4-16: PULLEY ALIGNMENT

- Blower assembly (Fig. 4-17)
  - Check the blower fan to ensure:
    - Proper clearance from housing
    - Free rotation
    - Proper operation of both the motor and the fan
  - Adjust the belt tension to ½"–¾" deflection at the center of the span.
  - Adjust the motor sheave to achieve the specified motor amperage as shown on the nameplate.
    - Exception: This does not apply to window/wall units with a fixed-pitch pulley.
  - Replace the belt if it is cracked or worn unevenly.
  - Verify that the blower shaft end play does not exceed 1/16".
  - Center the blower wheel end-to-end in the blower housing.

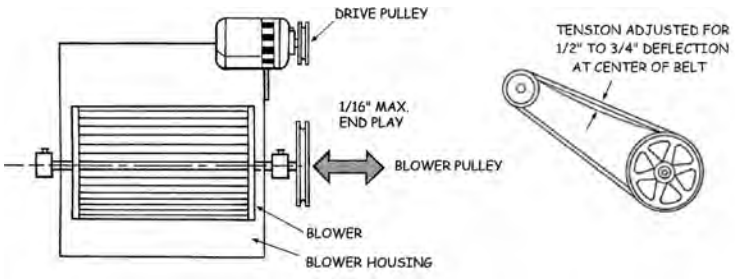


FIG. 4-17: BLOWER ASSEMBLY

4.5.2 (a2) Cooler pads and frames (Fig. 4-18)

- Clean and scrape the pad frames to remove mineral deposits.
- Replace deteriorated pads with new pads to achieve 1" thickness with a single 1" pad or two thinner pads.
- Trim the cooler pads to ensure complete coverage of the frame.

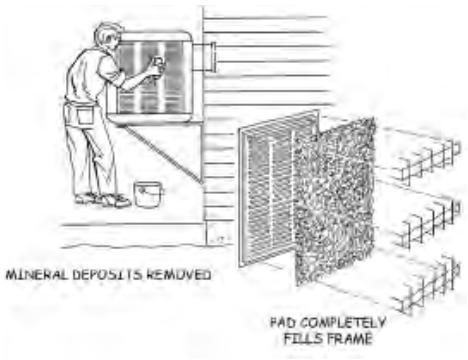


Fig. 4-18: Cooler Pads and Frames

4.5.2 (a3) Water supply and distribution

- Verify the water supply line to the cooler is free of leaks and provides adequate water flow.
- Replace existing damaged or leaking plastic line with minimum ¼" outside diameter (OD) copper and secure it with tube straps/brackets.
- Valves and fittings:
  - Install a brass shut-off valve if no shut-off valve exists:
    - Install a ¼" x ⅛" needle valve, or as required by local code.
    - A self-tapping needle valve is not allowed.
    - Position the outdoor shut-off to be reachable from ground level.
    - Install a brass anti-siphon valve if an anti-siphon valve is not present (Fig. 4-19).

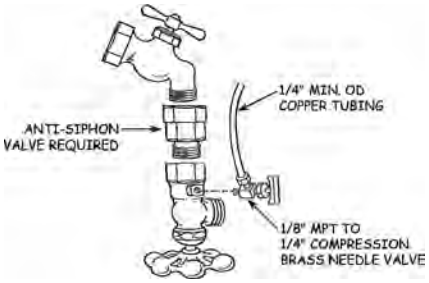


Fig. 4-19: Valves and Fittings

- Check the circulation pump, the purge pump (when present), and the screen for debris, mineral deposits, and adequate water flow.
- Verify the water distribution lines are free of obstructions and kinks and sealed at all connections.

4.5.2 (a4) Verify that drip trays are level and distribute water evenly to the cooler pads (Fig. 4-20).

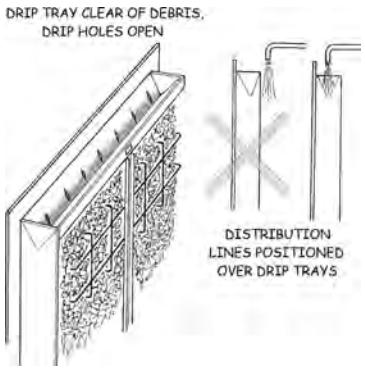


Fig. 4-20: Water Distribution to Drip Trays

4.5.2 (a5) Reservoir and float valve

- Check the reservoir and standpipe to verify that they are properly installed and free of leaks and debris.
- Clean rusted or deteriorated units and coat them with undercoating.
- Verify that the float valve shuts off incoming water completely when raised and the float splash shield prevents water from spraying away from the reservoir.
- Adjust the water level to be within ½"–1" of the top of the standpipe by turning the float level adjustment screw or bending the float rod.
- Do not install water additives (cooler cleaning and water treatment additives).

4.5.2 (a6) Drain system

- Install a drain line if it is missing.
- Verify drain lines are properly installed and free of leaks.
- Check wall/window-mount drain lines to ensure that:
  - Water flows away from the house
  - The end of the drain line is visible

- Check roof-mount drain lines to ensure that the drain line terminates in a rain gutter, in an approved drainage system, on the ground, or as required by the local jurisdiction.

4.5.2 (a7) Cooler ducting

- Repair disconnections and damage/leaks per Section 8 Ducting Repair, Sealing, and Insulation.
- When an evaporative cooler shares ducts with an FAU, a functional damper must be installed that will open while the evaporative cooler is being used and close at all other times to prevent the loss of conditioned air.

4.5.2 (b) Install

4.5.2 (b1) All units

- Install new units plumb, level, and securely attached to the mounting surface.
- Water supply and distribution
  - See Water supply and distribution
- Roof-mount unit drain:
  - Install a permanent drain line to prevent drain and overflow water from running onto the roof.
  - Terminate the drain line in a rain gutter, in an approved drainage system on the ground, or as required by the local jurisdiction.
  - Paint exposed PVC piping to resist ultraviolet degradation.

4.5.2 (b2) Window and wall units

- Location
  - Locate the cooler where only fresh air can enter and adequate room is available to service the unit (e.g., minimum 24" from side walls, solid fences, etc.).
  - Locate the cool air discharge where it will not disturb combustion appliance burners/pilots (e.g., in kitchen near gas range).
  - Window/wall-mount height
    - Locate the exterior portion of the unit a minimum of 12" above grade.
    - The air discharge outlet shall be located to conform with manufacturer's specifications. If no specifications exist, the location shall be a minimum of:
      - 3' above the floor unless mounted under a window
      - 18" above the floor if the discharge grille is equipped with directional louvers and the location is allowed by the manufacturer
        - Exception: The height of an existing location is acceptable if it is not in conflict with the manufacturer's instructions or local code.
- Window-mount opening:
  - Position the cooler in the center of the window opening.
  - Install permanent window panels to completely fill empty spaces.
    - Side window panels over 8" wide shall be transparent glass or polycarbonate.
  - Seal the window panels in place.
- Window/wall-mount cooler supports (Fig. 4-21):
  - Support the cooler with a metal brace, chain kit, or platform.
  - Anchor the brace supports with non-corrosive screws to solid wood
  - Anchors and chain support screws shall penetrate the framing members a minimum of ¾" (1" if the screws are self-drilling).
    - Brackets shall not be anchored to the window sash or trim.

  - The platform shall rest on a concrete pad or masonry supports and be braced.

- Wall-mount installation opening:
  - The wall shall be structurally sound and able to support the unit's weight and vibration.
  - The opening shall be framed internally with 2-by lumber/structural members (Fig. 4-22).
  - Flash/seal the opening in accordance with local code.
  - Trim the opening on the interior and exterior.
  - Prime and paint new wood to protect it from moisture damage (non-cosmetic painting only).
  - Use exterior-grade materials outdoors.
  - Openings in brick veneer and block walls:
    - Install the lintel and flashing above the opening when required.
    - Install flashing (drip rail) below the unit.
  - Seal the unit in place.

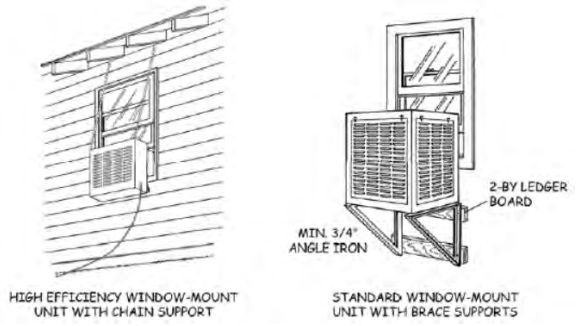


Fig. 4-21: Window/Wall-mount Cooler Supports

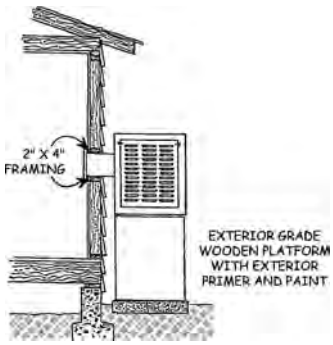


Fig. 4-22: Wall-mount Installation

- Window/wall electrical requirements
  - Protect exposed wiring by housing it in a conduit.
  - Properly ground the cooler cabinet and all metal junction boxes and conduits.
  - Connect plug-in units to a grounded three-wire receptacle.

4.5.2 (b3)

Roof-mount units

- Refer to Roof-Mount Appliances.
- Roof-mount barometric damper (Fig. 4-23)
  - When an evaporative cooler is connected to the HVAC duct system and they share the same ducts, an automatic barometric damper is required.
    - Exception: An automatic barometric damper is not required if a manual winter closure damper is present and operable from inside the dwelling.
      - A mechanical damper requiring manual operation from the roof is not allowed.
      - When a manual damper is installed, interior vent covers will not be feasible.

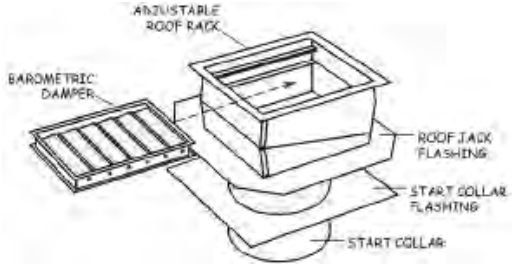


Fig. 4-23: Roof-mount Barometric Damper

- Supports
  - Bottom support system
    - Support the cooler with a wooden or angle iron stand, sheet metal curb, or support kit (e.g., roof jack and leg kit).
      - Do not support the cooler solely with the roof jack or duct.
    - The support system shall be stable, secure, and constructed in a manner that does not trap rain water.
  - A replacement unit may be installed on an existing support system that is the correct size, is in good condition, and meets all requirements of this section.
  - Platforms
    - See Appliance Enclosure, Platform, and Plenum.
  - Roof-mount support system attachments
    - Install support system attachments/anchors that are corrosion-resistant and chemically compatible screws, bolts, or lag bolts. (Nails and molly bolts are not allowed.)
    - Anchors must penetrate a minimum of 1" into solid wood.
      - Exception: Factory-fabricated leg kits and support systems may be anchored to the roof sheathing.
- Roof-mount cooler duct
  - See Section 8 Ducting Repair, Sealing, and Insulation.
- Diffuser/ceiling grille (Fig. 4-24) shall:
  - Direct air in at least two directions
  - Be equipped with adjustable/ closing louvers or with a positive damper
  - Be located where it will not disturb combustion appliance burners/pilots

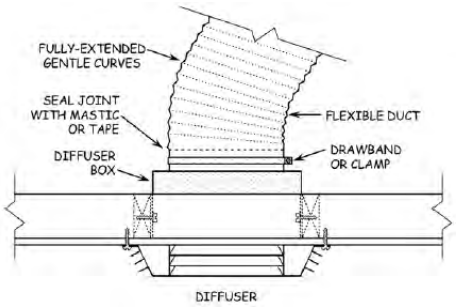


FIG. 4-24: DIFFUSER/CEILING GRILLE

- Cooler controls
  - Wall-mounted controls
    - Install controls in a switch/receptacle box.
    - Install the box and wiring inside the wall whenever possible.
    - When controls and/or wiring are surface-mounted, use an electrical box designed for surface mounting and enclose wiring in a raceway.
- Roof-mount electrical requirements
  - Hard-wire the cooler to an electrical circuit that has:
    - Proper overcurrent protection and grounding or ground fault circuit interrupter (GFCI) protection
    - Adequate current capacity to add the cooler
  - Install a service disconnect and service receptacle when required by local code.
  - Properly ground the cooler cabinet and all metal junction boxes and conduits.
  - Replacement units may use existing wiring if it is in good condition, safe, and adequate for the new cooler's controls and meets the requirements of this section.

4.6. Central Furnace

4.6.1 General Requirements

4.6.1 (a) Prohibited FAU locations

4.6.1 (a1) If an FAU is located in a bedroom (sleeping area) or bathroom and requires repair or replacement, refer to Appendix A Combustion Appliance Safety Protocol.

4.6.1 (b) Enclosure

4.6.1 (b1) See Appliance Enclosure, Platform, and Plenum.

4.6.1 (c) Access to equipment under floors and on roofs shall be provided in accordance with local code.

4.6.1 (d) Attic location requirements

4.6.1 (d1) See Fig. 4-25.

4.6.1 (d2) Refer to Section 1 General Installation Guidelines, Attic and Crawlspace Accessibility.

4.6.1 (d3) If not already present, permanent switch-controlled lighting shall be installed.

- The switch shall be located at the access/entrance and readily accessible.
- The lighting shall provide enough illumination to allow crew to safely approach the equipment and perform the task for which access is provided.

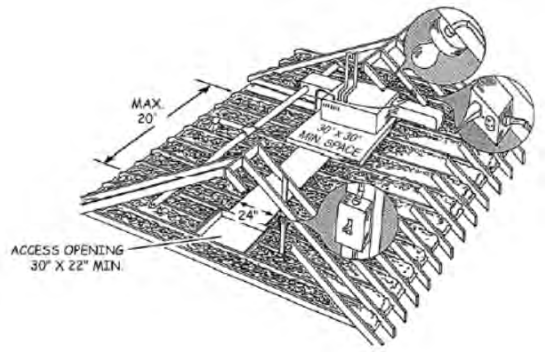


FIG. 4-25: ATTIC LOCATION REQUIREMENTS

4.6.1 (d4) If not already present, a permanent 120-volt convenience receptacle (outlet) shall be installed near the appliance.

4.6.2 Procedure

4.6.2 (a) Repair

4.6.2 (a1) Perform pre-combustion appliance safety testing to identify operational defects, as defined in the Appendix A Combustion Appliance Safety Protocol.

4.6.2 (a2) Make all necessary corrections when within the scope of the weatherization program. The scope of repairs must also take into consideration, but is not limited to, the following operational repairs:

- Heating unit integrity
  - Tighten loose items (e.g., screws, bolts, panels, etc.).
  - Replace or repair missing/damaged components critical to proper operation (e.g., access doors, roll-out shield, etc.).
  - Correct improper alterations that adversely affect unit operation.

4.6.2 (a3) Appliance filter(s)

- A dirty, defective, or missing furnace filter shall be corrected per Section 10 Air Filters.

4.6.2 (a4) Blower chamber

- Clean a dirty blower chamber and fan blades.
- Lubricate the bearings.
- Replace bearings in need of repair.

4.6.2 (a5) Evaporator coil box

- Clean or replace a dirty or damaged evaporator coil.
- Seal air leaks at plumbing or wiring penetrations (i.e., with cork tape).

4.6.2 (a6) Duct system testing and sealing

- See Appendix B Duct Leakage Testing Protocol.

- See Section 8 Ducting Repair, Sealing, and Insulation.

4.6.2 (b) Install

4.6.2 (b1) Removal of existing equipment

- Turn off electricity and natural gas before removing the old appliance.
- Disconnect refrigerant lines, plumbing, ducts, electric, control wires, vents, and fuel.

4.6.2 (b2) Appliance vent system installation (Fig. 4-26)

- Install and secure a new vent system in accordance with manufacturer's instructions, local code, and Appendix A Combustion Appliance Safety Protocol.
- When an existing furnace that shares a common vent with another appliance is replaced with a new unit, the contractor shall ensure that both appliances are properly vented.
- For natural gas furnaces and absorption heat pumps (gas-fired), an appliance vent system, CVA, and gas piping shall be installed in compliance with Appendix A Combustion Appliance Safety Protocol.

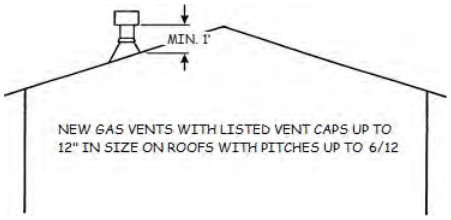


FIG. 4-26: APPLIANCE VENT SYSTEM INSTALLATION

4.6.2 (b3) CVA

- The flow of CVA shall not be obstructed by any part of the installation.
- CVA shall be adequate to supply combustion air in accordance with local code and the Appendix A Combustion Appliance Safety Protocol.
  - Corrections shall be made as needed to limit CO to acceptable levels.

4.6.2 (b4) Air distribution (duct) system

- See Section 8 Ducting Repair, Sealing, and Insulation.
- Verify the FAU is compatible with the existing duct system.
- Examine the duct system for leaks and disconnections and test it according to Appendix B Duct Leakage Testing Protocol.
- Repair and seal the duct system in accordance with manufacturer's instructions, Title 24 requirements, and Section 8 Ducting Repair, Sealing, and Insulation.
- Install new ductwork in accordance with manufacturer's instructions and Title 24 requirements.

4.6.2 (b5) Preparation of platform returns and plenums

- See Appliance Enclosure, Platform, and Plenum.

4.6.2 (b6) Gas line and fittings installation

- Install gas piping (e.g., risers, flexible connectors, fittings, and valves) in accordance with manufacturer's instructions.
- Install any additional components (e.g., drip leg, condensate drain, etc.) when required by the manufacturer or local code.
- Install a shut-off valve within 3' of the appliance and in the same room or space in which the appliance is located.

4.6.2 (b7) Air filter installation

- When an HVAC unit is replaced, install a filter (with minimum efficiency reporting value [MERV] 6 filtration or higher with no air bypass around the filter) in accordance with Section 10 Air Filters, local code, and manufacturer's instructions. The filter shall be considered part of the replacement measure.
  - A pre-manufactured or site manufactured durable filter slot cover will be installed

4.6.2(b8) Thermostats and controls

- Install a wall thermostat in accordance with Section 7 Thermostats—Smart, Programmable, and Manual and manufacturer's instructions.

4.6.2(b9) Power switches shall function properly, including the:

- Blower access lockout/safety switch
- Switch controlling power to the unit (disconnect)
- Blower speed control switch

4.7. Floor, Wall, and Freestanding Furnace

4.7.1 General Requirements

4.7.1(a) Furnace design and performance

4.7.1(a1) Heating capacity and system design shall conform with local code and the current Title 24 manuals.

4.7.1(a2) The furnace shall perform as designed and be properly sized for the living space.

4.7.1(b) Bedroom locations

4.7.1(b1) If an open combustion heating appliance is located in a bedroom (sleeping area) and requires repair or replacement, refer to Appendix A Combustion Appliance Safety Protocol.

4.7.1(c) Fire hazards

4.7.1(c1) For these heating types, if the existing appliance location (or the proximity of the client's possessions to the appliance) poses a potential fire hazard, the client shall be informed of the non-conforming condition.

4.7.1(c2) Minor fire hazards shall be removed/corrected by field personnel per Section 1 General Installation Guidelines, Limited Home Repair.

4.7.1(d) Clearances

4.7.1(d1) Appliance clearances shall be maintained in accordance with the requirements of the listing, manufacturer's installation instructions, California Mechanical Code (CMC), and local code.

4.7.1(e) CVA

4.7.1(e1) CVA shall be provided in accordance with manufacturer's instructions, local code, CMC, and Appendix A Combustion Appliance Safety Protocol.

4.7.2 Procedure

4.7.2(a) Repair

4.7.2(a1) Repairs may include, but are not limited to, the following operational repairs:

- Repair or replacement of missing/damaged components critical to proper operation (e.g., access doors, a roll-out shield, etc.)
- Correction of non-conforming venting
- Correct improper alterations that adversely affect unit operation
- Repair wiring defects (e.g., frayed or burned wires, loose or improper connections, etc.)
- Tightening of loose items (e.g., screws, bolts, panels, etc.)
- Flame adjustment

4.7.2(b) Install

4.7.2(b1) Floor/wall/freestanding furnaces (general)

- Seal all unnecessary holes in wall studs, floor, and bottom plate before installation of the unit.
- Do not modify the furnace unit (e.g., cutting support legs) unless allowed by manufacturer.
- Maintain proper clearances from combustibles (as described by the manufacturer).

- Install the furnace level and plumb.
- Properly align the unit to be free of metal stress expansion that causes banging and metal ticking.
- Controls
  - Furnace controls shall operate in accordance with manufacturer's specifications.
- Gas piping and valves
  - Replace non-conforming or unsafe connectors with code-compliant materials in accordance with Appendix A Combustion Appliance Safety Protocol.
  - A shut-off valve shall be present in accordance with local code.
- Gas control valve
  - Furnace valve shall turn properly and be free of fuel leaks and electrical defects (e.g., short or open).
  - Gas pressure shall comply with manufacturer's specifications.
- Venting
  - Appliance vent shall be installed and secured to conform with the manufacturer's requirements, CMC, and the venting tables in the Appendix A Combustion Appliance Safety Protocol.
  - Re-use of the existing vent system is only allowed if the vent is in good condition and complies with the unit listing, the manufacturer's requirements, and local code.
  - Direct vent terminal placement:
    - Locate the hole in the wall for the vent system between studs.
    - The vent terminal must meet clearance requirements from an opening into the home (openable window or door) or other air inlet in accordance with the Appendix A Combustion Appliance Safety Protocol.

4.7.2 (b2) Thermostat

- Install the thermostat in a location and mounting that complies with manufacturer's instructions and Section 7 Thermostats—Smart, Programmable, and Manual.
- Set the anticipator to 24-volt heating control circuit amperage, when applicable.
- After installation is complete, calibrate the thermostat per the manufacturer's instructions.

4.7.2 (b3) Wall furnace

- Wall furnace cabinet shall be secured to structural framing.
- Modifications shall not be made to the furnace (e.g., cutting support legs) unless allowed by manufacturer.
- Finished installation shall include blocking of all unnecessary holes in wall studs, floor, and bottom plate.
- Unit shall be properly aligned and free of metal stress expansion that causes banging and metal ticking.

4.7.2 (b4) Floor furnace

- Floor opening shall be framed on all four sides, and furnace cabinet shall be secured to structural framing.
- When required, a seepage pan shall be installed per CMC requirement.
- Access
  - Foundation wall opening at least 24" x 18", or trapdoor 24" x 24".
  - Passageway with minimum 24" x 18" cross-section.

- Controls
  - Control valve operation must be accessible from inside the residence.
  - Pilot light must be accessible for lighting from inside the residence.

4.7.2 (b5) Freestanding furnace

- Freestanding furnace shall be vented outdoors with correctly listed vent pipe. The vent shall extend above the roof line in conformance with the Appendix A Combustion Appliance Safety Protocol.
- Install floor protection when required.
- Room volume (CVA) must be adequate for installation.
- Controls
  - Control valve operation must be accessible from inside the residence.
  - Pilot light must be accessible for lighting from inside the residence.

4.7.2 (b6) Repairs to home following installation, see Roof-Mount Appliances.

4.7.2 (b7) All gas heat source appliances shall be tested after installation using the procedures outlined in the Appendix A Combustion Appliance Safety Protocol.

4.8. Wood Stove/Fireplace Insert

4.8.1 General Requirements

4.8.1 (a) Bedroom locations

4.8.1 (a1) When a gas log or wood-burning stove or fireplace is present in a bedroom (sleeping area), refer to Appendix A Combustion Appliance Safety Protocol.

4.8.1 (b) The wood stove/insert shall be properly sized for the home.

4.8.1 (c) The recipient and landlord (if not owner-occupied) shall agree that the wood stove/insert will remain in the residence where it is installed.

4.8.1 (d) Safety clearances for the appliance and chimney pipe shall be met in accordance with the manufacturer's instructions and applicable codes.

4.8.1 (e) If the primary heat source is a fireplace, pellet stove, or gas log system, it shall not be replaced.

4.8.2 Procedure

4.8.2 (a) Repair

4.8.2 (a1) The wood stove/insert inspection must be complete, including:

- Heating unit, vents, connectors, chimneys, and terminations
- Floor/wall protection
- Safety clearances
- Source of CVA

4.8.2 (b) Install

4.8.2 (b1) Check to determine that an appropriate location is available for proper, safe installation of a new wood stove/insert and chimney before:

- The existing unit is removed (when applicable)
- Structural preparation (e.g., cutting holes) for the new unit occurs

4.8.2 (b2) Location

- The wood stove/insert shall be located in the living room or other central location (Fig. 4-27).

FIG. 4-27: WOOD STOVE/INSERT CENTRAL LOCATION

- The space surrounding the installed wood stove/insert shall be of sufficient size to ensure proper clearance from combustibles and provide safe operation.

4.8.2 (b3) Chimney and components

- The existing chimney and components shall not be re-used, including the:
  - Ceiling support package when a vent connector is used
  - Insulation shield when penetrating an attic
  - Chimney cap and spark arrestor
- Connector/chimney sizing
  - The connector:
    - Shall be no smaller in diameter than the flue outlet, and
    - A maximum of 25% larger than the cross-sectional area of the flue outlet

4.8.2 (b4) CVA

- The wood stove/insert shall be designed to obtain CVA ducted directly from the outdoors to the air inlet.

4.8.2 (b5) Crawlspace ventilation

- When CVA is drawn from the crawl space, instead of being vented to the outdoors, the crawlspace must be ventilated (Fig. 4-28).
- The crawl space vents' NFVA shall be at least twice (double) the NFVA of the air intake opening for the stove.
- Vents shall be located on at least two opposite sides of the crawlspace in accordance with Section 41 Crawlspace Ventilation.

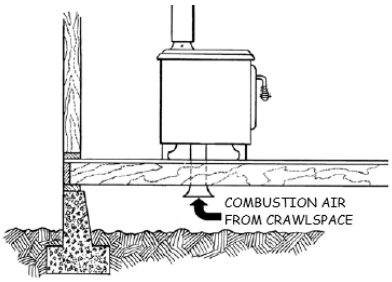


FIG. 4-28: COMBUSTION AIR FROM CRAWLSPACE

- When additional ventilation is needed, undampered crawlspace ventilation shall be installed.

4.8.2 (b6) Floor protection

- When required, a listed floor protector shall be installed in accordance with the manufacturer's requirement and applicable local codes.

4.8.2 (b7) Vent connector installation requirements

- Vent connectors shall be installed as follows unless otherwise specified by the wood stove/insert manufacturer.
- The vent run shall be as short and straight as possible and allow for proper and regular cleaning.
- Bends
  - Wood stoves/inserts with top vent outlet shall have a maximum of one 90º bend.
  - Wood stoves/inserts with rear vent outlet shall have a maximum of two 90º bends (including one at the wood stove/insert).
  - Installation of a tee is recommended at flue outlet to facilitate cleaning.
- Horizontal runs
  - There shall be a minimum ¼" rise per foot of run.
  - The maximum horizontal run will not exceed 75% of the vertical chimney height above the connector.

- Attachment
  - Single-wall vent connectors
    - Joints and connections shall be secured with a minimum of three sheet metal screws, evenly spaced.
  - Multi-wall vent connectors
    - Screws shall not be installed unless allowed in the manufacturer's instructions.
- Location restrictions
  - Vent connectors are limited to visible indoor locations and shall not be installed through a wall, ceiling, or roof or into any concealed space.

4.8.2 (b8) Factory-built chimney installation (Fig. 4-29)

- Chimney height shall be:
  - 3' above the highest point of roof penetration
  - 2' higher than any portion of a pitched roof, wall, evaporative cooler, or any other such object located within 10' of the chimney.
- Bracing
  - Chimneys extending more than 5' above the roof at the highest point of penetration shall be braced per manufacturer's instructions and applicable codes.

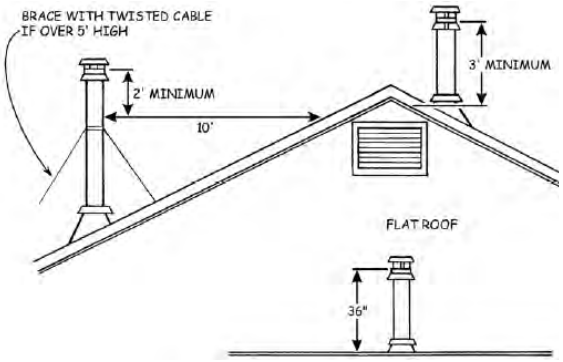


FIG. 4-29: FACTORY-BUILT CHIMNEY INSTALLATION

4.8.2 (b9) Penetrations

- Only listed chimney hardware shall be used at penetrations per the manufacturer's specifications (Fig. 4-30).
- Walls or ceilings: Heat protection specified by the manufacturer shall be installed.

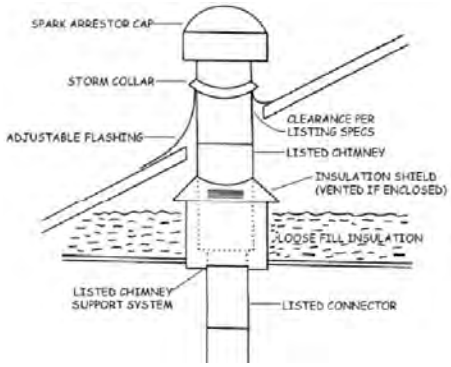


FIG. 4-30: CHIMNEY PENETRATIONS

4.8.2 (b10) Use of existing chimneys

- A wood stove/insert shall have its own continuous vent with cap and spark arrestor and be installed in accordance with local code.
  - Units can not share the vent of another appliance.
  - Routing the wood stove/insert connector into a masonry chimney is not allowed.
- An insert installed in a fireplace must be properly vented and cannot use the existing masonry chimney alone.

4.8.2 (b11) Floor anchors

- Freestanding wood stoves/inserts shall be firmly attached to the floor as specified by the manufacturer using their attachment hardware.

4.9. Appliance Enclosure, Platform, and Plenum

4.9.1 Enclosures

4.9.1 (a) FAU enclosure

4.9.1 (a1) Minimum access, service space, and enclosure size for required clearances and adequate CVA shall be provided in accordance with local code.

4.9.1(a2) The enclosure shall provide adequate service space for:

- A 120-volt receptacle and
- An appliance line valve

4.9.1(a3) The access door shall be:

- At least 24" wide, when installed by a crew
- High and wide enough to accommodate removal of the appliance

4.9.2 Attic Service Platforms

4.9.2(a) A code compliant walkway and service platform will be installed in the attic, if not present.

4.9.3 Exterior Equipment Platforms

4.9.3(a) Platforms shall be framed.

4.9.3(b) Ensure that water/debris is not trapped and that moisture can readily escape.

4.9.3(c) Cut ends and holes made in pressure-treated lumber shall be treated with preservative.

4.9.3(d) Plywood for bracing and sheathing shall be sealed with exterior primer and paint.

4.9.3(e) Wood components shall have at least 3" separation from the earth by concrete or other code-compliant base.

4.9.4 Platform Returns and Plenums

4.9.4(a) See Section 8 Ducting Repair, Sealing, and Insulation for sealing requirements of the duct system components.

4.9.4(b) Seal holes and gaps in the walls and floor of the appliance enclosure prior to installation of the appliance in accordance with Section 32 Infiltration Reduction.

4.9.4(c) Seal leaks in return air plenum and insulate plenum in accordance with Section 8 Ducting Repair, Sealing, and Insulation.

4.9.4(d) If platform return is accessed through an appliance enclosure door (a full-length door containing a return grille near the bottom):

4.9.4(d1) Verify the grille does not interfere with proper closure of the door.

4.9.4(d2) Isolate the return from the furnace enclosure (e.g., with weatherstripping that seals the gap between the platform and inside surface of the door).

4.9.4(e) Housing and plenum

4.9.4(e1) Mechanically attach and seal around the perimeter of the components (e.g., housing-to-platform, housing-to-plenum).

4.9.4(e2) Seal wiring and plumbing penetrations into the return air chamber with cork tape.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as for conventional homes except as specified in the following sections.

5.1.2 Permits, installation, and all materials used shall be in compliance with manufacturer's instructions and specifications, with requirements of Housing and Community Development (HCD), local code, and Appendix A Combustion Appliance Safety Protocol.

5.1.3 Egress requirements shall be comply with Section 1 General Installation Guidelines, Window Egress (Mobile Homes).

5.1.4 Mobile Home Air Distribution System for Ducted Heating/Cooling Types

5.1.4(a) Existing duct system and new ductwork

5.1.4(a1) Examination and testing shall conform with Appendix B Duct Leakage Testing Protocol.

5.1.4 (a2) Repair and sealing of existing/new ducts shall conform with Section 8 Ducting Repair, Sealing, and Insulation.

5.2. Mobile Home Central AC/Heat Pump

5.2.1 Mobile Home Self-Contained AC

5.2.1 (a) Installation of a self-contained AC (Fig. 4-31) sharing a common supply duct system with the furnace shall comply with the following requirements for damper and function control.

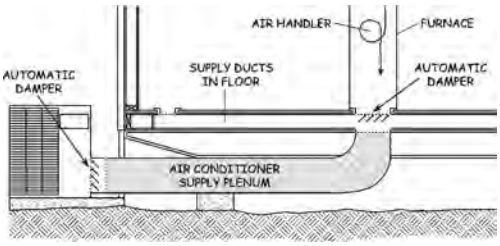


FIG. 4-31: MOBILE SELF-CONTAINED AC

5.2.1 (a1) Automatic damper

- The furnace shall have an automatic barometric damper installed to prevent cold air from entering the furnace when the HVAC system is in cooling mode.
- The AC shall have an automatic damper installed to prevent hot air from entering the AC unit when the HVAC system is in heating mode.

5.2.1 (a2) Function control

- The controls shall prevent the AC and furnace from coming on at the same time.

5.2.2 Electrical Wiring, Grounding, and Accessibility

5.2.2 (a) Electrical wiring, grounding, and unit accessibility shall conform with manufacturer's instructions, the Department of Housing and Urban Development (HUD) code, and/or, as applicable, the requirements of the local building department.

5.3. Mobile Home Evaporative Cooling

5.3.1 Window-/Wall-Mount Units

5.3.1 (a) Window/wall exterior clearances

5.3.1 (a1) Cooler air intake shall be located at least 3' from a gas vent pipe, solid-fuel chimney, bathroom or kitchen exhaust, clothes dryer exhaust, plumbing vent, vehicle exhaust source, attic vent, gas meter assembly, or other source of toxic contamination.

5.3.1 (a2) Minimum 24" clearance is required on all sides for maintenance.

5.3.1 (b) Window/wall location

5.3.1 (b1) All units

- The exterior portion of the unit shall be located a minimum of 12" above grade.
- The discharge shall not be located where it can disturb combustion appliance burners/pilots (e.g., in a kitchen near a gas range).

5.3.1 (b2) Wall-mount units

- Mobile homes with metal siding
  - The cooler shall be installed only in a window opening or an existing wall opening.
  - Cutting new wall openings is not allowed.

5.3.2 Roof-Mount Units

5.3.2 (a) Roof-mount clearances

5.3.2 (a1) The evaporative cooler intake shall be at least 3' from a gas vent pipe, solid-fuel chimney, bathroom or kitchen exhaust, clothes dryer exhaust, plumbing vent, vehicle exhaust source, attic vent, gas meter assembly, or other source of toxic contamination

5.3.2(b) Cooler supports

5.3.2(b1) The cooler shall be securely supported by such means as a rigid roof jack (minimum 18-gauge galvanized), angle iron or wooden stand, sheet metal curb, or factory-made support kit.

5.3.2(c) Roof jack and duct start collar

5.3.2(c1) Replacement units shall utilize the existing roof jack and duct start collar if they are the correct type and size, are in good condition, and meet all requirements of this section.

5.3.2(c2) Roof jack

- The roof jack shall match the roof slope or shall be adjustable.
- A leveling assembly (e.g., “levelers” at the top) may be used to compensate for the slight slope of a bow-string truss roof.

5.3.2(c3) The roof jack/cooler connection shall be sealed.

5.3.2(c4) Metal roofs

- The roof jack flashing shall be:
  - Under-coated with elastomeric sealant (e.g., polyurethane)
  - Installed over the metal roof (spanning two truss chords)
  - Secured with screws
    - At least four screws shall penetrate the chords and/or blocking.
  - Additionally sealed as needed to prevent water leakage at joints, seams, and anchor points
- In sloped locations, the metal skin may be slit on the high side, with the roof jack/flashing upper flange slid underneath.
- In locations adjacent to a ridge cap, the upper flange shall be placed under the ridge cap, when possible.

5.4. Mobile Home Central Furnace

5.4.1 An existing furnace in mobile home is not listed and approved for use in a mobile home shall be replaced (per current HUD code).

5.4.2 Location Restrictions

5.4.2(a) A gas or solid fuel furnace that draws CVA from a sleeping room or bathroom in a mobile home is a CAS hazard. See Appendix A Combustion Appliance Safety Protocol.

5.4.3 Preparation of Appliance Enclosure, Platform, and Plenum

5.4.3(a) Isolation of return air

5.4.3(a1) The return air system shall not have leaks that:

- Depressurize any open combustion appliance enclosure.
- Draw in CVA or combustion by-products from any open combustion appliance (e.g., from furnace itself or nearby water heater).
- Depressurize or draw air from a space where hazardous chemicals are stored, or toxic fumes may be present.

5.4.3(b) The following conditions are not allowed and shall be corrected, when feasible:

5.4.3(b1) An open-combustion FAU drawing non-ducted return air through a grille in the furnace cabinet.

5.4.3(b2) A closed-combustion FAU located in an appliance enclosure adjacent to an open combustion water heater when the furnace enclosure is part of the return system, and

5.4.3(b3) The two appliances are not separated by an airtight barrier.

5.4.3(b4) Any condition which allows pollutants to be drawn into the FAU return shall be corrected. If not correctable, the home shall be limited to non-infiltration measures only (the home shall be NIM).

5.4.3(c) Sealing of housing and plenum

5.4.3(c1) Components shall be mechanically attached and sealed around the perimeter (cabinet-to-duct connector, cabinet-to-plenum) using materials and methods prescribed in Section 8 Ducting Repair, Sealing, and Insulation.

5.4.3(c2) Plumbing and wiring penetrations into the evaporator coil box and return air chamber shall be sealed with cork tape.

5.4.4 CVA

5.4.4(a) CVA shall be supplied from outdoors in compliance with furnace listing, manufacturer's instructions, HCD regulations, and Appendix A Combustion Appliance Safety Protocol.

5.4.4(b) When a furnace draws CVA from undercarriage space:

5.4.4(b1) Undampered venting shall be present in the skirting

5.4.4(b2) Cross-ventilation shall be present, with venting located on at least two different sides of the mobile home skirting (Fig. 4-32)

5.4.4(b3) Skirting vents on each side shall provide at least 1½ sq. ft. NFVA for each 25 li. ft. of mobile home length

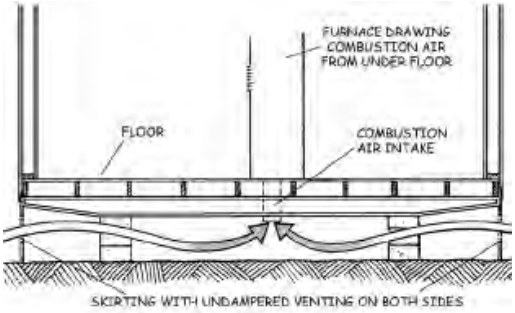


Fig. 4-32: Furnaces Drawing CVA from Undercarriage Space

5.4.5 Appliance Vent System

5.4.5(a) The existing vent system shall be replaced unless it:

5.4.5(a1) Is in good condition (free of leaks, deterioration, damage, etc.)

5.4.5(a2) Meets listing requirements of the replacement furnace

5.4.5(a3) Is in conformance with furnace manufacturer's instructions

5.5. Mobile Home Floor/Wall and Freestanding Furnace

5.5.1 When an existing furnace in a mobile home is not listed/approved for use in a mobile home (including open combustion unit in the living space) and it is the primary heat source, the furnace shall be replaced with a mobile home listed furnace in accordance with the current HUD code.

5.5.1(a) Replacement furnaces shall be closed combustion and listed for use in mobile homes.

5.6. Mobile Home Wood Stove/Fireplace Insert

5.6.1 An existing wood stove/insert in a mobile home that is not listed and approved for use in a mobile home (per current HUD Code) shall be replaced.

5.6.2 CVA

5.6.2(a) CVA shall come from outside the living space (outdoors) in accordance with HUD and HCD regulations.

5.6.2(b) CVA intakes shall be ducted through the envelope as specified by the manufacturer.

5.6.3 Crawlspace Ventilation

5.6.3(a) Skirting shall be ventilated when the undercarriage area is the source of CVA (Fig. 4-33).

5.6.4 Undampered venting shall be installed as needed.

5.6.5 Ventilation in the skirting shall be at least twice (double) the NFVA of the air intake opening for the stove.

5.6.6 Vents shall be installed and located on at least two opposite sides of the mobile home.

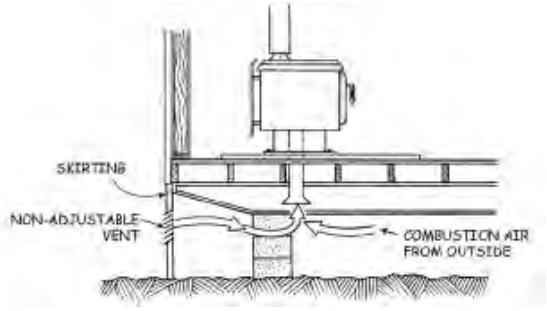


Fig. 4-33: Mobile Home Crawlspace Ventilation

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 Independent Heating and/or Cooling Sources

6.1.1(a) When an individual dwelling unit has an independently-operating heating and/or cooling source in a multi-family building, installation requirements are the same as those for conventional homes.

6.1.2 Common Heating and/or Cooling Systems (Serving Multiple Dwelling Units)

6.1.2(a) When a heating and/or cooling source serves multiple-units in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.2(b) Repair or replacement of a common heating and/or cooling system:

6.1.2(b1) Is allowable due to Health & Safety (H&S) under LIHEAP

6.1.2(b2) Requires an energy audit under the Department of Energy (DOE). See Assessment Requirements

6.1.3 Common Area Heating and/or Cooling Sources

6.1.3(a) Common area installation (e.g., in a boiler room, utility room, etc. within the same thermal boundary as dwelling units) is allowed when justified by an energy audit for a whole-building project, per Appendix D Energy Audit/Priority List Protocol.

6.1.3(a1) When a heating and/or cooling source heats/cools a common area in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3(b) Common area installation is not allowed when only an individual unit in a multi-family building will be served.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 A heating and/or cooling “system” can mean a central unit or several individually operating units; however, when a central unit is in place, it shall be considered the primary unit, and all other units are to be considered secondary.

7.1.2 When an appliance condition is identified that would allow this measure to be repaired or replaced under H&S, an audit is required first to determine if the appliance could be replaced as an energy efficiency upgrade. If the SIR is <1.0, H&S repair or replacement may be allowed as defined below.

7.1.3 To assess for this measure (and the associated thermostat) as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.3(a) The form will determine if the measure will be installed in the Audit path or the Priority List (PL) path.

7.1.3(b) When assessing this measure for the Audit path, measure feasibility will be decided by the energy audit with a Measure savings-to-investment ratio (SIR) and Dwelling SIR.

7.1.3(c) When assessing for the measure in the PL path, the feasibility will be based on building type and characteristics.

7.1.3(c1) PL measures are classified as Mandatory or Optional based on building type.

- Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.
- Optional measures may be installed only after all feasible Mandatory PL measures have been installed.

7.1.4 For the Priority List Path:

7.1.4(a) Specific types of heating and cooling replacements are identified in the Priority List for each building type.

7.1.4(a1) If not specifically listed, a site-specific energy audit shall be required.

7.1.4(b) All H&S-related heating and cooling repairs and replacements (including the associated thermostat) must be fully leveraged to an alternative funding source.

7.1.5 For the Audit Path:

7.1.5(a) To install this measure (and the associated thermostat) in the DOE Audit path, a site-specific energy audit is required to determine if it will be an energy conservation measure or a Health and Safety measure.

7.1.5(b) Measure feasibility will be determined through the energy audit with a Measure savings-to-investment ratio (SIR) and Dwelling SIR.

7.1.5(b1) When the Measure SIR ≥1.0, the energy conservation measure may be paid for with DOE funds.

7.1.5(b2) When the Measure SIR <1.0, and a H&S condition exists, it is a H&S measure.

7.1.6 If a client refuses a feasible Audit path Major measure, Mandatory Priority List path, or Health & Safety measure, the entire dwelling shall be deferred.

7.1.7 When this measure is fully leveraged or co-funded with LIHEAP, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/ Priority List Protocol.

7.1.8 Cooling Systems

7.1.8(a) Primary AC system replacement, repair, or installation is allowed only in homes where current occupants meet Grantee's definition of "at-risk", per the Appendix E Health and Safety Requirements.

7.1.9 Heating Systems

7.1.9(a) Primary Systems

7.1.9(a1) A safe primary heating system (vented to the outdoors) must be present, or repair/replacement/installation must be feasible.

- Refer to Appendix A Combustion Appliance Safety Protocol for policies specific to appliance types and building types.
- If an unvented combustion space heater is the primary heat source, it must be replaced with a vented heat source prior to weatherization and be sized to heat the entire dwelling unit.
- Appliance abandonment is not allowed.
- If repair/replacement/installation is not feasible, deferral is required.
- It is required to provide a cost comparison between replacement and repair when a H&S condition is identified.

7.1.9(b) Gas Log or Wood-burning Stove or Fireplace Insert

7.1.9(b1) When a gas log or wood-burning stove or fireplace insert is present in the living space, refer to Appendix A Combustion Appliance Safety Protocol. The woodstove/insert shall be properly sized for the home.

- Conduct a safety inspection including, but not limited to, visual inspection of the entire system, verification of adequate floor protection, and code-compliant clearances to walls and other combustible materials.
- It is required to perform visual draft testing of the fireplace/woodstove to ensure proper operation of the appliance as detailed in Appendix A Combustion Appliance Safety Protocol, Table 15.5.1.
- Fireplace or woodstove venting that is left operational after weatherization must meet current state (California Mechanical Code), local, and national standards or the home must be deferred.
  - If the primary heat source is a fireplace, pellet stove, or gas log system, it shall not be replaced.

7.1.9(c) Secondary Systems

7.1.9(c1) Unsafe secondary heat sources must be repaired, or removed and disposed of, or dwelling deferral is required.

7.1.9(c2) Unsafe secondary heat sources that cannot be repaired must be removed. Abandonment is not allowed.

- Unsafe portable space heaters must be removed.

7.1.9(c3) A secondary space heater is considered unsafe if it:

- Is not listed and labeled as meeting ANSI Z21.11.2
- Has an input rating of more than 40,000 BTU/hour
- Is in a bedroom and have an input rating of more than 10,000 BTU/hour
- Is in a bathroom and have an input rating of more than 6,000 BTU/hour
- Operates in an unsafe manner (e.g., high carbon monoxide (CO) readings, too close to combustible materials, lack sufficient combustion air volume, etc.)
- Is not allowed by the Authority Having Jurisdiction (AHJ)
- Is in a mobile home, and it is not vented to the outdoors.

7.1.9(c4) Removal of the appliance shall be billed under the “Disposal” line-item category for all labor and disposal fees pertaining to the appliance.

7.1.9(d) Mobile Home Combustion Appliances

7.1.9(d1) Combustion appliances in mobile homes must comply with the Manufactured Home Construction and Safety Standards, which mandates that:

- All combustion appliances installed by or left in place after weatherization in mobile homes must meet these standards.
- For mobile homes, malfunctioning combustion appliances shall be repaired or replaced before weatherization or they must be removed in accordance with Appendix A Combustion Appliance Safety Protocol.
- All fuel-burning appliances in mobile homes except ranges, ovens, illuminating appliances, clothes dryers, solid fuel-burning fireplaces and solid fuel-burning stoves, must be installed to provide for the complete separation of the combustion system from the interior atmosphere of the mobile home (i.e., to draw their combustion air from outside), and be vented to outside the dwelling.
- Repair or replacement of combustion gas venting shall be performed when necessary to ensure proper combustion gas venting to outside the dwelling for all combustion appliances, including but not limited to gas dryers and refrigerators, furnaces, vented space heaters, and water heaters.
- Nonconformance with this requirement will require correction or removal of the appliance.
- If a client will not allow removal of an unsafe combustion appliance (primary or secondary) from the home, deferral is required.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2(a) Excerpted from 2017 SWS 5.3003.5:

7.2.2(a1) Refrigerant lines

- [Central AC/heat pump] High-side or liquid refrigerant lines shall not be insulated unless otherwise specified by the manufacturer.

7.2.2(b) Excerpted from 2017 SWS 5.3003.6:

7.2.2(b1) The sequence of operation of the system will be verified in accordance with the manufacturer installation, operation, and maintenance manual. If every effort to secure the manufacturer’s manual proves unsuccessful, the technician will rely on standard industry testing protocols.

7.2.3 Mobile Home

7.2.3(a) Excerpted from 2017 SWS 5.3003.15:

7.2.3(a1) Frames of home sections will be bonded with copper wire

7.2.3(a2) Bonding lug will be selected to prevent corrosion due to dissimilar metals

7.2.4 If weatherization installs an appliance where the existing appliance was vented into a masonry chimney, the chimney must be lined in compliance with the International Fuel Gas Code (IFGC), California Mechanical Code, and local code (if more stringent).

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Check that the unit was installed properly and that the heating and/or cooling source operates as intended by the manufacturer.

8.1.2 Verify that all electrical and refrigerant line connections are correct and secure.

8.1.3 Test the controls of the heating and cooling unit to ensure proper operation in all modes.

8.1.4 If provided, program the remote control per the manufacturer's instructions.

8.1.5 CAS Check (Combustion units)

8.1.5(a) All new and affected gas lines and components shall be checked for gas leaks by a method approved by the local jurisdiction

8.1.5(b) CO in flue gas shall be tested to be within limits specified by:

8.1.5(b1) Appendix A Combustion Appliance Safety Protocol or

8.1.5(b2) Manufacturer's instructions, if more stringent

8.2. Client Education

8.2.1 The client shall be supplied with both verbal and written instructions (user manuals) for:

8.2.1(a) Proper operation of all user-accessible controls

8.2.1(b) Routine maintenance recommended by the manufacturer, including filter replacement

8.2.1(c) Removal and installation of winterizing materials

8.2.1(d) Safety considerations, such as:

- Safe placement of interior furnishings with respect to the heat source
- Keeping the appliance area, return grilles and supply registers clear of furniture, dust, debris, hazardous chemicals, and other blockages
- Combustion air inlet locations and the importance of keeping inlets open
- Importance of leaving interior doors open as much as possible
- Importance of keeping outside unit clear of debris, vegetation, decks, and other blockage
- Indoor and outdoor electrical disconnects and fuel shut-offs
- When applicable, information about the proper disposal of bulk fuel tanks when not removed as part of weatherization work
- Where combustion equipment is present, information including how to recognize depressurization and the dangers of CO poisoning associated with combustion appliance use

8.2.1(e) Situations when the occupant should contact the HVAC contractor will be explained, including:

8.2.1(e1) Fuel odors

8.2.1(e2) Water draining from secondary drain line

8.2.1(e3) Emergency heat indicator always on for a heat pump system

8.2.1(e4) System blowing warm air during cooling season

8.2.1(e5) Icing of the evaporator coil during cooling mode

8.2.1(e6) Outside unit never defrosts

8.2.1(e7) Unusual noises or odors

8.2.1(e8) Warranty information

8.2.1(f) Issues regarding multiple systems running will be discussed with occupant

8.2.1(g) Equipment manuals and warranties

8.3. Clean-Up and Disposal Requirements

8.3.1 Replaced parts, filters, and debris shall be removed from the property and disposed of properly.

8.3.2 All hazardous waste materials shall be disposed of in accordance with federal, state, and local code.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 Air Conditioner, Furnace, or Heat Pump

9.1.1(a) LIHEAP: 19 years

9.1.1(b) DOE: 15 years (Furnace: 20 years)

9.1.2 Evaporative Cooler or Wall Heater

9.1.2(a) LIHEAP: 15 years

9.1.2(b) DOE: 15 years

9.1.3 Window/Wall Air Conditioner

9.1.3(a) LIHEAP: 14 years

9.1.3(b) DOE: 14 years

9.2 All Heating and Cooling Units

9.2.1 Appliance Sizing and Selection

9.2.1(a) Building heating and cooling loads, used for equipment sizing and selection, shall be determined based on any one of the following:

9.2.1(a1) ACCA Manual J, or

9.2.1(a2) Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Residential Comfort System Installation Standards Manual, or

9.2.1(a3) American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) Handbook (Equipment, Applications and Fundamentals Volumes)

9.2.1(a4) Equipment selection will be performed in accordance with ANSI/ACCA Manual S and manufacturer specifications

9.2.1(b) The unit shall be sized to meet the minimum requirements, but not larger than necessary and in accordance with Title 24 and local code.

9.2.2 Air Filter

9.2.2(a) Filters shall be selected in accordance with those prescribed in Section 10 Air Filters.

9.2.3 Ducts and Sealants

9.2.3(a) Materials shall conform with those prescribed in Section 8 Ducting Repair, Sealing, and Insulation.

9.2.4 Thermostats

9.2.4(a) Programmable, smart, and manual wall thermostats shall be selected in accordance with Section 7 Thermostats—Smart, Programmable, and Manual.

9.2.5 Gas Pipes and Valves

9.2.5(a) Gas valves must be UL-listed and American Gas Association (AGA)- or Canadian Standards Association (CSA)-certified.

9.2.5(b) Gas flexible connectors must be International Association of Plumbing and Mechanical Officials (IAPMO)–listed epoxy-coated or stainless-steel units.

9.2.5(c) Pilot tubing shall be aluminum. Copper is not allowed.

9.2.5(d) Fuel-gas piping shall be selected, sized, and installed per CMC, Chapter 13. Copper gas lines are not allowed.

9.2.6 Vent Pipes

9.2.6(a) Metal vent pipes

9.2.6(a1) All metal vent pipes, vent connectors and components shall be UL-listed.

9.2.6(a2) Gas vent pipe shall be Type B or B-W.

9.2.6(b) Non-metallic combustion air and vent pipes

9.2.6(b1) Pipes and fittings shall be labeled to conform to American Society of Testing and Materials (ASTM) D 1785 and D 2665.

9.2.6(b2) Pipe cement and primer shall be labeled to conform to ASTM D 2564.

9.2.7 Refrigerant Theft Protection

9.2.7(a) Locking caps shall be brass with integral O-ring and a covering that is color-coded or labeled for the refrigerant type.

9.3 Central Cooling

9.3.1 The AC shall have a minimum seasonal energy efficiency ratio 2 (SEER2) and energy efficiency ratio 2 (EER2) depending on AC type:

9.3.1(a) Package units

9.3.1(a1) Minimum SEER2 of 13.4 and EER2 of 10.6

9.3.1(b) Split systems

9.3.1(b1) Less than 45 kBtuh: minimum SEER2 of 14.3 and EER2 of 11.7

9.3.1(b2) Greater than or equal to 45 kBtuh: minimum SEER2 of 13.8 and EER2 of 11.2

9.3.1(b3) If the split system is rated SEET of 16.0 or greater, the unit must have a minimum EER2 rating of 9.8.

9.3.2 SEER shall be determined by the coil and condenser combination as listed in the current AHRI directory.

9.4 Central Heat Pumps

9.4.1 Package units

9.4.1(a) Minimum heating season performance factor 2 (HSPF2) of 6.7

9.4.1(b) Minimum SEER2 of 13.4

9.4.2 Split systems

9.4.2(a) Minimum HSPF2 of 7.5

9.4.2(b) Minimum SEER2 of 14.3

9.4.3 The SEER2 and HSPF2 shall be determined by the coil and condenser combination as listed in the current AHRI Directory.

9.4.4 Dual fuel heat pumps: The furnace shall conform with Central Furnace.

9.5 Mini-Split Heat Pumps

9.5.1 All ductless mini split heat pumps shall:

9.5.1(a) Be ENERGY STAR®–certified

9.5.1(b) Have a minimum 15 SEER, 12.5 energy efficiency ratio (EER), and 8.5 HSPF

9.5.1(c) Be a wall-mount, floor-mount, or ceiling cassette type

9.5.1(d) Include a programmable thermostat

9.5.2 Indoor and outdoor units performance shall be verified by AHRI listing.

9.5.3 In colder climates with >3,600 heating degree days (HDD), units must comply with National Energy Efficiency Guidelines (NEEP) guidelines.

9.6 Wall/Window AC

9.6.1 All replacement window/wall-mounted ACs and heat pumps shall be:

9.6.1(a) UL-listed and ENERGY STAR®–certified

9.6.1(b) Equipped with:

9.6.1(b1) Minimum two-speed fan

9.6.1(b2) Adjustable thermostat with a minimum of six positions

9.6.1(b3) Removable filter

9.6.1(b4) Minimum four-way air directional control

9.6.1(c) Rated with a minimum combined EER compliant with Table 4-3

TABLE 4-3: MINIMUM COMBINED EER

Appliance	Cooling Capacity (Btuh) with Louvered Sides	Minimum Combined EER	Cooling Capacity (Btuh) without Louvered Sides*	Minimum Combined EER
Window/Wall AC	<6,000	11.0	<6,000	10.0
	≥6,000–7,999	11.0	≥6,000–7,999	10.0
	≥8,000–13,999	10.9	≥8,000–10,999	9.6
	≥14,000–19,999	10.7	≥11,000–13,999	9.5
	≥20,000–27,999	9.4	≥14,000–19,999	9.3
	≥28,000	9.0	≥20,000	9.4
Room AC Heat Pump	<20,000	9.8	<14,000	9.3
	≥20,000	9.3	≥14,000	8.7
Casement-Only Room AC	Any	9.5	Any	9.5
Casement-Slider Room AC	Any	10.4	Any	10.4
*Without louvered sides = Through-the-wall units				

9.6.1(d) Wall units must be equipped with a through-the-wall chassis (sleeve).

9.6.1(e) Unit sizing: The new unit shall comply with manufacturer's recommendations and the sizing guidelines outlined in Table 4-4

Table 4-4: Replacement Unit Capacity Based on Square Footage of Area to Be Cooled

Area to Be Cooled (Sq. Ft.)	Capacity (Btuh)*
100–150	5,000
151–250	6,000
251–300	7,000
301–350	8,000
351–400	9,000
401–450	10,000
451–500	12,000
501–700	14,000
701–1,000	18,000

*Adjustments:
If the room is heavily shaded, reduce capacity by 10%.
If the room is very sunny, increase capacity by 10%.
If more than two people regularly occupy the room, add 600 Btuh for each additional person.
If the unit is installed in a kitchen, increase capacity by 4,000 Btuh.

9.7 Cooling—Evaporative

9.7.1 All Units

9.7.1(a) UL-listed (or equivalent) and compliant with UL 507.

9.7.1(b) Surface burning characteristics shall be per UL 723 and ASTM E-84.

9.7.1(c) Air movement shall have been factory-tested per ANSI/Air Movement and Control Association Standard 210.

9.7.1(d) Equipped with a code-compliant automatic cleaning device, such as an automatic flushing system (e.g., timed purging).

9.7.1(d1) A bleed-off system may be used only when allowed by the local jurisdiction.

9.7.1(e) Installed unit sizing requirements per Table 4-5:

Table 4-5: Cooler Sizing Guidelines

Cooler Capacity (Airflow in CFM)	Maximum Sq. Ft. Area	
	At 3.0 CFM per sq. ft. (22 air changes/hour [ACH]) (Average Climate)	At 4.0 CFM per sq. ft. (30 ACH) (Hot, Dry Climate)
3000	1000	750
3500	1165	875
4000	1330	1000
4500	1500	1125
5000	1665	1250
5500	1830	1375
6000	2000	1500
6500	2165	1625

9.7.2 Media—Standard Pads (Fig. 4-34)

9.7.2(a) Pads shall be:

9.7.2(a1) Aspen excelsior bound in netting or

9.7.2(a2) Honeycomb cellulose fiber pad or

9.7.2(a3) The type specified by the cooler manufacturer

9.7.2(b) All pads shall have minimum 1" thickness. (Two thinner pads may be used to achieve 1" thickness.)

9.7.2(c) The size shall be as specified by the cooler manufacturer.

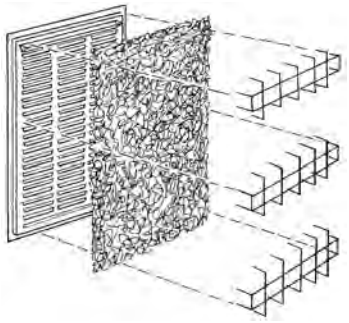


FIG. 4-34: STANDARD EXCELSIOR COOLER PAD

9.7.3 Media—High-Efficiency (Fig. 4-35)

9.7.3(a) Only rigid media shall be used.

9.7.3(b) The size shall be as specified by the cooler manufacturer.

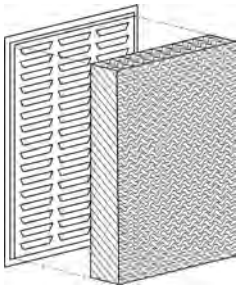


FIG. 4-35: HIGH-EFFICIENCY COOLER PAD

9.7.4 Replacement Blower Motor

9.7.4(a) The replacement motor shall be:

9.7.4(a1) UL-listed or a UL-recognized component designed for moist conditions

9.7.4(a2) Equipped with thermal overload protection

9.7.4(a3) Wired for at least two speeds

- Exception: If the existing motor is single-speed, the replacement may be single-speed.

9.7.4(a4) Rated at 115/120 volts, 60 Hz, single phase

9.7.5 Replacement belts shall be general purpose “A” or “4L” section utility belts.

9.7.6 Pump Requirements

9.7.6(a) The pump shall be:

9.7.6(a1) A UL-listed or a UL-recognized component

9.7.6(a2) A grounded UL-recognized motor with thermal overload protection

9.7.6(a3) Protected from water damage to the motor winding (e.g., by shaft sleeve, skirting, etc.)

9.7.6(b) The pump shall have a molded screen or other factory-supplied screening device to keep debris out of the impeller.

9.7.7 Water Supply Shut-Off Valve and Fittings

9.7.7(a) Valves and fittings shall be brass only.

9.7.7(b) A self-tapping needle valve is not allowed.

9.7.8 Drain Line

9.7.8(a) Acceptable drain line materials include copper, PVC, and galvanized pipe.

9.7.9 Supports

9.7.9(a) Window-/wall-mount cooler supports:

9.7.9(a1) All metal brace support material shall be minimum ¾" x ¾" angle iron or equivalent.

9.7.9(a2) All metal shall be primed, anodized, painted, galvanized, or corrosion-resistant (e.g., aluminum).

9.7.9(b) Metal frame components

9.7.9(b1) Use minimum ¾" x ¾" 16-gauge angle iron or equivalent for the support stand.

9.7.9(b2) All metal shall be primed, anodized, painted, galvanized, or corrosion-resistant (e.g., aluminum).

9.7.9(c) Materials for wooden platforms shall be:

9.7.9(c1) Exterior-grade

9.7.9(c2) Sealed with exterior primer and paint

9.7.9(d) Window/wall cooler attachments shall comply with the manufacturer's minimum specifications; however:

9.7.9(d1) Non-corrosive screws or lag bolts shall be used

9.7.9(d2) Nails and molly bolts are not allowed

9.7.9(e) Framing

9.7.9(e1) Use minimum 2x4 pressure-treated lumber or redwood.

9.7.9(f) Plywood for bracing and sheathing

9.7.9(f1) Use exterior-grade materials.

9.7.10 Supply Lines

9.7.10(a) Replacement supply lines shall be minimum ¼" OD copper tubing.

9.8 Central Furnace

9.8.1 Conventional Home Furnaces

9.8.1(a) Units shall conform with the requirements of the current California Building Code (CBC), CMC, DOE, Title 24 Residential Compliance Manual, and Title 20 Appliance Efficiency Regulations.

9.8.1(b) Unit efficiency shall be verified by inclusion in the California Energy Commission (CEC) database of certified appliances.

9.8.1(c) All units and components shall be UL-listed and/or certified by CSA, AGA, or AHRI.

9.8.1(d) Split systems

9.8.1(d1) Minimum annual fuel utilization efficiency (AFUE) rating: 80%

9.8.2 Package Units (Dual Packs)

9.8.2(d1) Minimum AFUE rating: 81%

9.8.2(d2) If replaced in conjunction with the furnace, the AC shall have a minimum SEER2 of 13.4.

9.8.3 Oil-Fired Furnaces

9.8.3(a) Split system minimum AFUE rating: 83%

9.8.3(b) Package unit minimum AFUE rating: 78%

9.8.3(c) Mobile home minimum AFUE rating: 75%

9.8.4 Mobile Home Furnaces

9.8.4(a) Units installed in a mobile home shall be listed for use in a mobile home.

9.8.4(b) Units shall be sealed combustion when inside the living space.

9.8.5 Mobile Home Gas Furnaces

9.8.5(a) Minimum AFUE rating: 80%

9.8.5(b) Materials installed inside a mobile home shall comply with HCD regulations.

9.8.5(c) Materials installed outside a mobile home shall comply with HCD regulations or, as applicable, the requirements of the local building department.

9.9 Floor/Wall and Freestanding Furnace

9.9.1 Units shall conform with the requirements of the current CBC, CMC, DOE, Title 24 Residential Compliance Manual, and Title 20 Appliance Efficiency Regulations.

9.9.2 Installed appliances shall be:

9.9.2(a) UL-listed and/or certified by CSA or AGA

9.9.2(b) Closed combustion and listed for use in a mobile home when installed in a mobile home

9.9.2(c) The most efficient model feasible to install, but no lower in efficiency than specified in Table 4-6

TABLE 4-6: MINIMUM HEATING EFFICIENCY FOR NON-DUCTED, NON-CENTRAL, GAS-FIRED HEATING EQUIPMENT

Furnace Type	Btuh Output Capacity	Minimum AFUE (%)
Wall Furnace with Fan	≤42,000	75%
	>42,000	76%
Wall Furnace without Fan	≤27,000	65%
	≥27,001–≤46,000	66%
	>46,000	67%
Floor Furnace	≤37,000	57%
	>37,000	58%
Freestanding Room Heater	≤20,000	61%
	>20,000–≤27,000	66%
	>27,000–≤46,000	67%
	>46,000	68%
Source: Title 24 2022 Residential Compliance Manual, Section 4.2		

9.10 Wood Stove/Fireplace Insert

9.10.1 Wood Stove/Insert

9.10.1(a) Only new wood stove/insert manufacturer–approved, factory-built, and laboratory-listed equipment and other hardware shall be installed.

9.10.1(b) All wood stoves/inserts shall bear a permanently-affixed label stating “For use with solid fuel only.”

9.10.1(c) Where applicable, any installed wood stove/insert shall comply with the EPA Phase II emission limits and shall bear temporary label(s) certifying it conforms to EPA emission standards.

9.10.2 Units Installed in Mobile Homes

9.10.2(a) Units installed in mobile homes shall:

9.10.2(a1) Draw CVA from outdoors and

9.10.2(a2) Bear a permanent manufacturer’s label stating the wood stove/insert is approved for use in mobile homes

9.10.3 Chimneys, Connectors, and Components

9.10.3(a) Chimneys and connectors must be factory-built, laboratory-listed, Class A–types specified by the manufacturer, including:

9.10.3(a1) A ceiling support package when a vent connector is used

9.10.3(a2) An insulation shield when penetrating an attic

9.10.3(a3) A chimney cap and spark arrestor

10. WARRANTY

Appliance	Manufacturer	Contractor
Central AC/Heat Pump		
Repair	90 days	1 year
Install	5 years (compressor) 1 year (other)	1 year
Central Heat Pump		
Repair	90 days	1 year
Install	5 years (compressor) 1 year (other)	1 year
Mini-Split Heat Pump		
Install	5 years	1 year
Evaporative Cooler		
Repair	90 days	1 year
Install	5 years (reservoir pan) 1 year (other)	1 year
Wall/Window AC		
Repair	90 days	1 year
Install	5 years (compressor) 1 year (other)	1 year
Central Furnace/Heat Pump		
Repair	90 days	1 year
Install	1 year	1 year
Floor/Wall and Freestanding Furnace		
Repair	90 days	1 year
Install	1 year	1 year
Wood Stove/Fireplace Insert		
Install	3 years (stove) 1 year (other)	1 year

5. ECM Blower Motors

Table of Contents

ECM Blower Motors

1. MEASURE OBJECTIVE

1.1 A high-efficiency, variable-speed, electronically commutated motor (ECM) saves energy when installed to replace an existing direct-drive permanent split capacitor (PSC) blower motor in a central forced air unit (FAU).

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 The dwelling is cooled by a central heating, ventilation, and air conditioning (HVAC) system (package unit, split system, heat pump, or hydronic system) with an operable or inoperable direct-drive PSC blower motor

2.2.2 All FAU housing access panels are functional

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The existing central FAU:

3.1.1 Will be replaced

3.1.2 Is inaccessible, is non-operational, or requires service or repair that is not feasible under Section 4 Heating and Cooling

3.1.3 Has a defective or excessively leaky plenum or duct system that cannot feasibly be sealed or replaced per Section 8 Ducting Repair, Sealing, and Insulation

3.1.4 Is on a recall list (e.g., the Consumer Product Safety Commission [CPSC] Recall List [https://www.cpsc.gov/Recalls])

3.1.5 Has inadequate clearance for the new motor

3.2 The replacement blower motor requires a special mounting hardware/bracket that cannot feasibly be installed

3.3 Installation would violate the Appendix E Health and Safety Requirements

3.4 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 This measure may be installed in any primary or secondary HVAC system, as defined in Section 4 Heating and Cooling.

4.1.2 Any needed HVAC service or repair shall be completed per Section 4 Heating and Cooling.

4.1.3 If required, CAS testing shall be performed per Appendix A Combustion Appliance Safety Protocol.

4.2. Installation Procedure

4.2.1 The air filters in the existing HVAC unit must be cleaned or replaced in accordance with Section 10 Air Filters.

4.2.2 The static pressure in the supply plenum shall be measured with the PSC motor running.

4.2.3 Electrical

4.2.3(a) Best practice: Photograph or label the existing wiring connections for reference before commencing the installation.

4.2.3(b) The motor voltage and rotation direction shall be set.

4.2.3(c) The ECM blower motor speed that produces the same static pressure in the supply plenum as the PSC motor shall be selected.

4.2.3(c1) For an inoperable motor, use the HVAC manufacturer's data to estimate the design static pressure (up to a maximum of 0.8 inches of water column).

4.2.3(d) Place a completed ECM wiring label/sticker near the existing wiring diagram.

4.2.4 Operational Tests and Adjustments

4.2.4(a) Measure the system airflow.

4.2.4(b) Adjust the ECM blower motor speed to achieve:

4.2.4(b1) The same supply plenum static pressure as the PSC motor

4.2.4(b2) The design cubic feet per minute (CFM) per ton of cooling, when applicable

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 Independent FAU

6.1.1(a) When an individual dwelling unit has an independently operating FAU in a multi-family building, installation requirements are the same as those for conventional homes.

6.1.2 Common System (Serving Multiple Dwelling Units)

6.1.2(a) When a centralized air system serves multiple dwelling units and/or common areas (e.g., lobby, entertainment room, kitchen, etc.) in a multi-family building, the installation of this measure is not allowed.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Proper operation of the ECM blower shall be tested in the heating and/or cooling and fan-only modes and adjust/set as needed.

8.2. Client Education

8.2.1 Explain the energy-saving operation of the ECM to the customer.

8.2.2 Occupants shall be advised that the ECM may sometimes operate at slower speeds, which may result in perceived abnormally warm and/or cool air coming from the supply registers.

8.3. Clean-Up and Disposal Requirements

8.3.1 The replaced blower motor shall be recycled/disposed of in accordance with local waste management requirements.

8.3.2 All packaging materials and debris shall be cleaned up and removed from the premises.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life:

9.1.1 LIHEAP: 10 years

9.1.2 DOE: Not applicable to this measure.

9.2 The motor component shall be:

9.2.1 Underwriters Laboratories (UL)– or Canadian Standards Association (CSA)–listed

9.2.2 A variable-speed ECM with a horsepower and torque rating that closely matches that of the existing motor and produces the required static pressure

9.3 Accessories (when required by the blower motor manufacturer or local code):

9.3.1 A digital programmer compatible with the motors it will program

9.3.2 Commercially available replacement motor mounting hardware compatible with the ECM being installed

10. WARRANTY

10.1 Manufacturer—2 years minimum

10.2 Contractor—1 year

6. Efficient Fan Controllers

Table of Contents

Efficient Fan Controllers

1. MEASURE OBJECTIVES

1.1 Installation of an efficient fan controller (EFC)/fan delay extends the air handler runtime to extract more heating/cooling from a central forced air unit (FAU).

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 The dwelling is cooled by a central heating, ventilation, and air conditioning (HVAC) system (package unit, split system, heat pump, or hydronic system) that is operating safely and properly and

2.2.2 All FAU housing access panels are functional and

2.2.3 The HVAC system has a 24-volt alternating current (AC) thermostat and blower control

2.2.4 The HVAC unit is one of the following types:

2.2.4(a) High-efficiency (with or without a condensing furnace) with a brushless permanent magnet (BPM) fan motor

2.2.4(b) Standard efficiency with a permanent split capacitor (PSC) fan motor

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The existing central FAU:

3.1.1 Is inaccessible, non-operational, or requires service or repair that is not feasible under Section 4 Heating and Cooling

3.1.2 Has a defective or excessively leaky plenum or duct system that cannot feasibly be sealed or replaced per Section 8 Ducting Repair, Sealing, and Insulation

3.1.3 Is on a recall list (e.g., the Consumer Product Safety Commission [CPSC] Recall List [https://www.cpsc.gov/Recalls])

3.1.4 Does not have a suitable location to install an EFC

3.1.5 Already has an EFC installed

3.2 Installation would violate Appendix E Health and Safety Requirements

3.3 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 This measure may be installed in any primary or secondary HVAC system, as defined in Section 4 Heating and Cooling.

4.1.2 Any needed HVAC service or repair shall be completed per Section 4 Heating and Cooling.

4.1.3 If required, CAS testing shall be performed per Appendix A Combustion Appliance Safety Protocol.

4.2. Installation Procedure

4.2.1 The air filters in the existing HVAC unit must be cleaned or replaced in accordance with Section 10 Air Filters.

4.2.2 Verify proper operation of the HVAC system in heating and/or cooling mode and proper thermostat voltage (24-volt AC) before attempting installation.

4.2.3 Best practice: Photograph or label the existing wiring connections for reference before commencing the installation.

4.2.4 Install the EFC as an additional control component (not to replace any existing component).

4.2.5 Operate the furnace (when it is cold outside) or the air conditioner (when it is warm outside) for the prescribed amount of time and make adjustments as needed.

4.2.5(a) The time delay for the equipment will be set as appropriate for the climate zone (e.g., no time delay for hot humid climates).

4.2.6 Attach a manufacturer's retrofit identification label and instructions to the modified appliance.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 Independent Forced Air Units (FAU)

6.1.1(a) When an individual dwelling unit has an independently operating FAU in a multi-family building, installation requirements are the same as those for conventional homes.

6.1.2 Common System (Serving Multiple Dwelling Units)

6.1.2(a) When a centralized air system serves multiple dwelling units and/or common areas (e.g., lobby, entertainment room, kitchen, etc.) in a multi-family building, the installation of this measure is not allowed.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Check the fan-off time delay for proper operation in heating and air conditioning modes.

8.2. Client Education

8.2.1 Explain the function of the EFC to the client.

8.3. Clean-Up and Disposal Requirements

8.3.1 All replaced parts, packing materials, and other debris shall be cleaned up and disposed of or recycled properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 10 years

9.1.2 DOE: Not applicable to this measure.

9.2 The EFC shall:

9.2.1 Be compatible with the HVAC or heat pump unit on which it is installed

9.2.2 Include a control module and wiring harness

9.2.3 Have the following certifications:

9.2.3(a) Low-voltage (24-volt AC) controllers: Listing not required

9.2.3(b) Line voltage (110-volt AC) controllers: Underwriters Laboratories (UL) or equivalent listing required

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

7. Thermostats—Smart, Programmable, Manual

Table of Contents

Thermostats—Smart, Programmable, Manual

1. MEASURE OBJECTIVES

1.1 An operable thermostat is necessary for the proper functioning of a heating, ventilation, and air conditioning (HVAC) system.

1.2 A programmable thermostat can save significant energy over a manual version.

1.3 A smart thermostat saves energy by automatically changing the set temperature according to learned behavioral patterns of heating and cooling.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 All Thermostat Types

2.2.1(a) The new thermostat to be installed is compatible with the heating and/or cooling appliance and

2.2.1(b) A qualified technician has determined that the existing thermostat has a performance issue and is not operating as intended or

2.2.1(c) A new thermostat is required in conjunction with a heating or cooling appliance replacement

2.2.2 Programmable Thermostat

2.2.2(a) The setback feature has been explained to the client and the client agrees to the installation and

2.2.2(a1) A manual thermostat is present or

2.2.2(a2) The existing programmable thermostat is inoperable or

2.2.2(b) The replacement thermostat has a saving-to-investment ratio (SIR) of ≥1.0

2.2.3 Smart Thermostat

2.2.3(a) The existing HVAC system is controlled by a 24-volt, wall-mount, manual or programmable HVAC thermostat, even if it is not functional or is missing or

2.2.3(b) The replacement thermostat has a saving-to-investment ratio (SIR) of ≥1.0

2.2.4 Manual (Non-Programmable) Thermostat

2.2.4(a) It is determined that the client will not be able to operate and maintain a new programmable or smart thermostat or

2.2.4(b) The heating or cooling system (e.g., a non-central electric heater, room air conditioner [AC], wall heater, etc.) does not support a programmable or smart thermostat

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1. All Thermostat Types

3.1.1 The heating and/or cooling system is:

3.1.1(a) Not present or

3.1.1(b) Inoperable and will not be repaired or replaced

3.1.2 An upgrade to the thermostat wiring (heavier gauge or more conductors) is required and cannot be corrected under this measure

3.1.3 An electrical issue is present and repair is not feasible

3.1.4 Installation would violate the Appendix E Health and Safety Requirements

3.1.5 The client refuses after measure benefits have been explained by the assessor

3.2. Programmable Thermostat

3.2.1 A programmable or smart thermostat is present and operational

3.2.2 Heating or cooling is provided by a heat pump

3.3. Smart Thermostat

3.3.1 A smart thermostat is already present and operational

3.3.2 The HVAC system uses a thermostat that is:

3.3.2 (a) Millivolt type or

3.3.2 (b) Labeled for 120- or 240-volt (line voltage wiring is present)

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Audited Measures

4.1.1 (a) When this measure will be installed under the Low Income Home Energy Assistance Program (LIHEAP) and an energy audit is performed, if the measure will be fully leveraged or co-funded it must comply with Appendix D Energy Audit/Priority List Protocol.

4.1.1 (b) When this measure is paid for by LIHEAP, or is co-funded with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply.

4.1.2 All Thermostats

4.1.2 (a) New thermostat location:

4.1.2 (a1) A new thermostat shall replace one at the existing location unless the location is affected by drafts, heat from direct sun, or adjacent appliances.

4.1.2 (a2) Thermostats shall be installed in the HVAC zone to control the temperature for that zone.

4.1.2 (a3) The new thermostat shall be mounted according to manufacturer specifications or, at a minimum:

- On a partitioning interior wall in a location of average temperature
- Away from:
  - Direct sunlight, entrance doors, windows, corners, areas behind interior doors, and supply air registers
  - Water pipes, heat-producing appliances, and sources of electrical interference
  - Sources of humidity, if a humidistat is a feature within the thermostat

4.1.2 (a4) When the manufacturer's specification is different than the minimum described above, a copy of the manufacturer's specification shall be available for inspection verification.

4.1.2 (a5) The thermostat shall be mounted with the top of the unit 60" above the floor and free of obstructions that inhibit airflow (Fig. 7-1).

- Exception: The thermostat shall be mounted as low as 48" above the floor when the occupant uses a wheelchair.

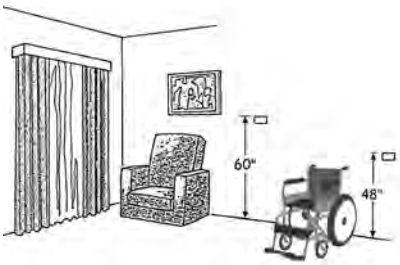


FIG. 7-1: THERMOSTAT HEIGHT REQUIREMENTS

4.1.2 (b) Two HVAC systems or a multi-zoned HVAC system:

4.1.2 (b1) The installation of two thermostats (manual, programmable, or smart) is allowable in homes where two existing programmable or manual thermostats are present.

4.1.2(b2) One thermostat may be installed to control two heating units to meet the setback requirement.

4.1.3 Smart Thermostats

4.1.3(a) Location:

4.1.3(a1) Thermostat shall be in a room with frequent use.

4.1.3(b) Electrical safety requirements:

4.1.3(b1) If it is not feasible to fix identified electrical issue(s), then installation of the smart thermostat shall be deferred.

4.2. Installation Procedure

4.2.1 All Thermostats

4.2.1(a) The heating and/or cooling system must be de-energized before the existing thermostat is removed.

4.2.1(b) Mounting the thermostat:

4.2.1(b1) The mounting bracket shall be securely attached to the wall with screws into wood, or with manufacturer-specified anchors for drywall and plaster.

4.2.1(b2) The hole where wires come through the wall must be very small or sealed (e.g., with spackle) to prevent drafts from affecting the accuracy of the thermostat.

4.2.1(b3) Any holes or damage to the wall from the installation or removal of a thermostat shall be repaired and patched to match the existing finish. (Matching paint to the wall color is not within the program scope.)

4.2.1(b4) If a humidistat is included with the thermostat, it shall be installed according to manufacturer's instructions.

4.2.1(c) Wiring:

4.2.1(c1) Install all wiring inside wall cavities when possible.

4.2.1(c2) Exposed wiring must be enclosed in a raceway.

4.2.1(d) Set-Up

4.2.1(d1) Set the thermostat to match the type and configuration of equipment.

4.2.1(d2) Program the temperatures and times in accordance with the client’s comfort and wishes.

4.2.1(d3) Verify the anticipator setting if appropriate for the thermostat model.

4.2.2 Programmable Thermostat

4.2.2(a) The time delay shall be set as appropriate for the climate zone (e.g., no time delay for hot, humid climates).

4.2.3 Smart Thermostat

4.2.3(a) Electrical requirements

4.2.3(a1) Voltage check:

- Determine if there is line voltage, as indicated by:
  - The thermostat being labeled 120-volt or 240-volt and/or
  - The presence of line voltage wires (e.g., thick conductors with wire nuts) and/or
  - Voltage measurement with a test instrument
- Proceed only if the existing thermostat control system is 24-volt.

4.2.3(a2) Install wiring according to the manufacturer’s instructions.

4.2.3(b) Programming

4.2.3(b1) The installer options will be set to match the thermostat to the equipment and control board settings.

4.2.3(c) Ensure that smart home features or interactive mode(s) are activated/programmed.

4.2.4 Heat Pump Thermostat

4.2.4(a) An outdoor temperature sensor shall be installed and configured.

4.2.4(b) The settings and configuration shall match the equipment.

4.2.4(c) Supplementary heat will be wired onto a second-stage heating terminal in accordance with the manufacturer's specifications.

4.2.4(d) Supplementary heat shall be used on air-to-air heat pumps with conditions that allow for a balance point of less than 30˚F. The supplementary heat lockout shall be installed and set to the manufacturer's specifications.

4.2.4(e) For air-to-air heat pumps, low ambient compressor lockout shall be set per manufacturer specifications.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 Independent FAU

6.1.1(a) When an individual dwelling unit has an independently-operating FAU in a multi-family building, installation requirements for this measure are the same as those for conventional homes.

6.1.2 Common System (Serving Multiple Dwelling Units)

6.1.2(a) The installation of this measure is allowed when justified by an energy audit for a whole-building project per Appendix D Energy Audit/Priority List Protocol.

6.1.2(b) When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.2(c) When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.2(c1) Common area installation for this measure is not allowed.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 To assess for programmable and smart thermostats (and the associated Heating and Cooling measure) as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.1(a) The form will determine if the measure will be installed in the Audit path or the Priority List (PL) path.

7.1.1(b) When assessing this measure for the Audit path, measure feasibility will be decided by the energy audit with a Measure savings-to-investment ratio (SIR) and Dwelling SIR.

7.1.1(b1) PL measures are classified as Mandatory or Optional based on building type.

- Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.
- Optional measures may be installed only after all feasible Mandatory PL measures have been installed.

7.1.2 For the Priority List Path:

7.1.2(a) When assessing for the measure in the PL path, specific types of heating and cooling replacements are identified in the Priority List for each building type.

7.1.2(a1) If not specifically listed, a site-specific energy audit for the heating and/or cooling appliance (and the associated thermostat) shall be required.

7.1.2(b) All H&S-related thermostat replacements (must be fully leveraged to an alternative funding source.

7.1.3 For the Energy Audit Path:

7.1.3(a) To install this measure in the DOE Audit path, a site-specific energy audit is required to determine if the heating and/or cooling appliance and associated thermostat will be an energy conservation measure or a Health and Safety measure.

7.1.3(b) Measure feasibility will be determined through the energy audit with a Measure savings-to-investment ratio (SIR) and Dwelling SIR.

7.1.3(b1) When the Measure SIR ≥1.0, the energy conservation measure may be paid for with DOE funds.

7.1.3(b2) When the Measure SIR <1.0 and a H&S condition exists, it is a H&S measure.

7.1.4 Note: Manual and programmable thermostats may qualify as a Health & Safety measure only when the existing thermostat has a performance issue and is not operating as intended.

7.1.5 If a client refuses a feasible Audit path Major measure, Mandatory Priority List path, or Health & Safety measure, the entire dwelling shall be deferred.

7.1.6 When this measure is fully leveraged or co-funded with LIHEAP, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/ Priority List Protocol.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2(a) None

7.2.3 Mobile Home

7.2.3(a) Extracted from 2017 SWS 5.3003.11:

7.2.3(a1) Mounting location for air leakage and conductance that would affect the thermostat operation (e.g., marriage walls, exterior walls) will be accessed.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 The thermostat shall be cycled to ensure proper operation of all functions.

8.1.2 Terminals on the gas valve and at the system control shall not be shorted (jumped) to test the installation.

8.1.3 The thermostat shall be returned to its pre-test settings.

8.2. Client Education

8.2.1 Verbal instructions, including proper use of the thermostat, shall be provided.

8.2.2 Appropriate use of heat pump emergency heat shall be explained.

8.2.3 Written instructions, such as those included with/on the unit packaging, shall be provided.

8.2.4 Smart and programmable thermostats:

8.2.4(a) The thermostat shall be programmed with the client present in accordance with the manufacturer's instructions, considering the client's wishes.

8.3. Clean-Up and Disposal Requirements

8.3.1 Packaging materials (except those with usage instructions), replaced appliances, and other debris shall be removed from the premises and disposed of properly.

8.3.2 Thermostats containing mercury shall be disposed of in accordance with universal waste regulations as set forth by the Department of Toxic Substances Control (DTSC) and the Environmental Protection Agency (EPA).

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 10 years

9.1.2 DOE: 15 years

9.2 All thermostats shall be compatible with the HVAC equipment they control.

9.3 Programmable thermostats shall:

9.3.1 Have a lithium or alkaline battery for power and for backup

9.3.2 Be system-powered, not battery-powered, on 24-volt systems

9.3.3 Have battery backup or another program-saving backup system

9.3.4 Be digital with a built-in anti–short cycle feature

9.3.5 Have at least four setback periods per 24-hour day with:

9.3.5(a) Change cycle increments ≤30 minutes

9.3.5(b) Setback capability ≥10˚F

9.3.6 Be programmable for both weekdays and weekends

9.3.7 Have a manual override and a positive on/off switch that is easily accessible

9.4 Smart thermostats must:

9.4.1 Be ENERGY STAR–certified

9.4.2 Be certified to meet Title 24 requirements

9.4.3 Include a trim plate to cover holes from the previous installation

9.4.4 Accommodate a common ("C") wire when one is present at the installation location

9.4.4(a) Note: If a C wire in good condition is not present at the installation location, install a new C wire or an approved adapter kit (Fig. 7-2).

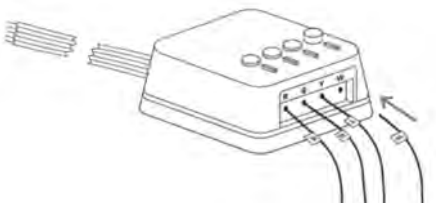


FIG. 7-2: C-WIRE ADAPTER KIT

9.5 Manual thermostats:

9.5.1 May be digital or analog (if requested by the customer) with a built-in anti–short cycle feature

9.5.2 Must include a positive on/off switch

9.6 Heat pump thermostats shall:

9.6.1 Be smart thermostats that minimize the use of supplementary electric resistance heating during start-up and recovery from setbacks

9.6.2 Prevent supplementary electric resistance heater operation when the heat pump alone can meet the heating load

9.6.3 Have a supplementary heat lock-out that interfaces with an outdoor temperature sensor

9.7 Wiring

9.7.1 All wiring shall be 18-gauge and conform to manufacturer's specifications and local code.

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

8. Ducting Repair, Sealing, and Insulation

Table of Contents

Ducting Repair, Sealing, and Insulation

1. MEASURE OBJECTIVES

1.1 Ducts that are functional, sealed, and insulated transfer conditioned air efficiently throughout the home.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair/Install

2.1.1 Duct Repair/Sealing

2.1.1(a) Existing ducts must be repaired or replaced in conjunction with the installation of a new heating or cooling unit or

2.1.1(b) Duct sealing measures are determined to be feasible as defined in Appendix B Duct Leakage Testing Protocol and CSD 706 Duct Leakage Data Sheet for one of the following priority levels:

2.1.1(b1) Priority 1—Catastrophic duct leaks

2.1.1(b2) Priority 2—High-pressure duct leaks

2.1.1(b3) Priority 3—Low-pressure duct leaks

2.1.2 Duct Insulation

2.1.2(a) Ducts and components are made of uninsulated, rigid metal

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1. Do Not Repair/Install

3.1.1 Duct Repair/Sealing

3.1.1(a) Ducts are inaccessible (e.g., located in cavities between multi-unit dwellings or attic/crawlspace clearance is inadequate per Section 1 General Installation Guidelines, Attic and Crawlspace Accessibility)

3.1.1(b) Evidence of rodent or pest infestation is present inside the duct

3.1.1(c) Ducts are made, sealed, or insulated with asbestos

3.1.1(d) Ducts (including plenums) are inside the conditioned living space

3.1.1(e) The forced air unit (FAU) is inoperable, inaccessible, or abandoned

3.1.1(f) Catastrophic duct leakage exists that cannot be corrected

3.1.1(g) Installation would violate the Appendix E Health and Safety Requirements

3.1.1(h) The client refuses after measure benefits have been explained by the assessor

3.1.2 Duct Insulation

3.1.2(a) Ducts are in an exposed outdoor location and it is not feasible to install exterior-rated insulation

3.1.2(b) Installation would violate the Appendix E Health and Safety Requirements

3.1.2(c) The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 The air handler shall be turned off during the application of all tapes and sealants and shall remain off for the drying time specified by the sealant manufacturer.

4.1.2 Audited Measures

4.1.2(a) When this measure will be installed under the Low Income Home Energy Assistance Program (LIHEAP) and an energy audit is performed, if the measure will be fully leveraged or co-funded it must comply with Appendix D Energy Audit/Priority List Protocol.

4.1.2(b) When this measure is paid for by LIHEAP, or is cost-shared with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply.

4.1.3 HERS Rater Verifications

4.1.3(a) Duct repair, sealing, and replacements that require HERS vertifcation include when:

4.1.3(a1) 25' or more of new or complete replacement duct is installed

4.1.3(a2) New or replacement HVAC ducts, air-handling units, cooling or hearting coils, or plenums are located in a garage space

4.1.3(a3) New duct or fully replaced duct, when installing a replacement kitchen exhaust.

4.1.4 Accessibility and Clearances

4.1.4(a) The attic or crawlspace where the ducts are located shall be accessible, when required, in accordance with the clearance requirements identified in Section 1 General Installation Guidelines, Attic and Crawlspace Accessibility.

4.1.5 Environmental Hazards

4.1.5(a) If potential asbestos, vermiculite, or other hazards are present that could be impacted by sealing activities, the duct system shall be assessed in accordance with Appendix E Health and Safety Requirements, Asbestos Policy.

4.1.5(b) All combustion appliance safety (CAS) hazards, CAS fails, or indoor air quality (IAQ) fails must be corrected before sealing activities begin per Appendix A Combustion Appliance Safety Protocol.

4.1.5(c) When a home is limited to non-infiltration measures (home is NIM), no duct testing or sealing shall be performed until the issue that created the NIM condition is resolved.

4.1.5(d) Prior to duct sealing, an inspection will be conducted for water leaks and water damage.

4.1.5(d1) All feasible moisture repairs will be completed before duct sealing work begins.

- See Section 1 General Installation Guidelines, Limited Home Repair for specific examples of moisture repair.

4.2. Duct Leakage Assessment

4.2.1 Assessors shall perform a visual inspection of all accessible portions of the duct system to:

4.2.1(a) Identify catastrophic leaks, disconnections, damage, gaps, and failed sealants (Fig. 8-1).

4.2.1(b) Assess the need for duct leakage testing and prioritize duct sealing activities as listed on the CSD 706 Duct Leakage Data Sheet.

4.2.1(c) Assess the need for duct insulation per Duct Insulation.

4.2.2 Duct leakage testing shall be completed in all feasible dwellings with duct systems, per Appendix B Duct Leakage Testing Protocol.

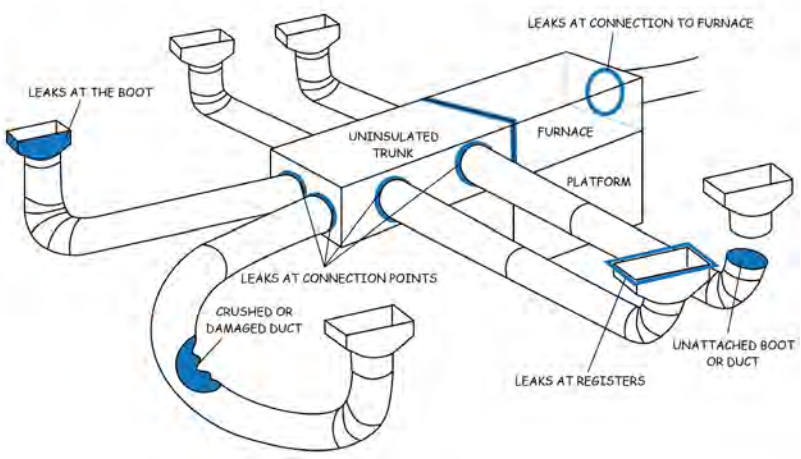


FIG. 8-1: DUCT SYSTEM WITH COMMON LEAKAGE AREAS—CONVENTIONAL HOME

4.3. Prioritization of Sealing Activities

4.3.1 Once leaks have been identified, duct sealing activities shall be prioritized per Table 8-1.

4.3.1(a) All required HVAC appliance replacements must be completed before duct sealing activities.

4.3.2 Sealing priority levels shall be utilized in numerical order from Priority 1 to Priority 3.

4.3.3 Duct sealing activities shall be performed in the order presented within each priority level, unless the activity is documented to be unfeasible.

4.3.4 If feasible sealing activities are skipped and are not justified in writing, those sealing activities will fail inspection.

4.3.5 Certain leaks may require more than one sealing technique to be resolved.

TABLE 8-1: DUCT SEALING PRIORITY LEVEL AND INSTALLATION GUIDELINE DIRECTORY

PRIORITY 1: Catastrophic duct leaks are present		
Priority	**Sealing Activity**	**Installation Guideline Section**
Priority 1	• Crushed duct	• Correction of Catastrophic Leaks
	• Disconnected ducts	
	• Seal/insulate unlined/unsealed plenum or platform return	
	• A damper to separate an FAU and an evaporative cooler is missing	
	Mobile Home	
	• Abandon the belly cavity. Install a central ducted return • If installing a new central ducted return is not feasible: − Seal accessible portions of supply side (e.g., gaps in plenum, duct connector, ductwork, register boots), and gaps at return plenum	• Correction of Catastrophic Leaks (Mobile Home)

TABLE 8-1: DUCT SEALING PRIORITY LEVEL AND INSTALLATION GUIDELINE DIRECTORY

PRIORITY 2: High-pressure duct leaks are present		
Priority	**Sealing Activity**	**Installation Guideline Section**
Priority 2	• Seal plenum/cabinet connections	• Correction of an Unlined/Unsealed Plenum
	• Seal plenum starting collar (access through side of the plenum)	
	• Line platform return (access through platform wall)	• Sealing Building Cavities
	• Secure register boots and risers that are loose or detached from the floor	• Sealing at Register Boots
	Mobile Home	
	• Duct terminations (dead ends) within reach:	• Sealing at Duct Terminations (Mobile Home)
	− Connect duct joints/splices and other loose metal overlaps	
	− Seal leaks in the duct connector underneath the furnace (access through removable bottom panel on the front of unit)	
	• Duct terminations beyond reach:	
	− Repair/seal from underneath the mobile home, or	
	− Secure with a sheet metal dam and permanently seal	
	• Seal furnace enclosure bypasses affecting the return, such as ceiling bypasses at the vent pipe penetration	• Application of Duct Sealant
Priority 2 (cont.)	• Seal duct joints reachable from indoors	• Sealing from Registers
	• Seal duct joints requiring access through the bellyboard	• Application of Duct Sealant
PRIORITY 3: Low-pressure duct leaks are present		
Priority	**Sealing Activity**	**Installation Guideline Section**
Priority 3	• Seal at all building cavities used as ducts, e.g., pan joists, stud cavities, toe kicks, chases, and dropped ceilings	• Sealing Building Cavities
	• Seal at register boots	• Sealing at Register Boots
	• Flexible duct: Seal at seams, wyes and elbows	• Sealing Flexible Non-Metallic Ducts
	• Rigid duct: Seal at seams, joints, wyes, and elbows.	• Sealing Rigid Ducts
	Mobile Home	
	• Seal at duct connectors (under the FAU)	• Sealing from Registers (Mobile Home)
	• Install, secure, support and seal at crossover ducts.	• Crossover Ducts (Mobile Home)
	• Seal at ducted returns	• Sealing Ducted Returns (Mobile Home)
	• Repair holes in bellyboard.	• Rodent Barrier (Bellyboard) Repair (Mobile Home)

4.4. Correction of Catastrophic Leaks

4.4.1 Install new duct to correct crushed, damaged, disconnected, or missing duct.

4.4.1 (a) When installed, new duct runs shall be:

4.4.1 (a1) Installed with at least 4" of separation from earth/soil

4.4.1 (a2) Installed in locations not exposed to the weather unless designed for exterior use

4.4.1 (a3) Protected from physical damage

4.4.1 (a4) Installed with new collars and sleeves (fittings) as prescribed in Sealing at Duct Fittings (Ells, Tees, Reducers) for Flexible Non-Metallic Ducts

4.4.1 (a5) Sealed at all duct seams, splices (joins), and joints with mastic or metallic tape (Fig. 8-2)

4.4.1 (a6) Installed with duct supports as prescribed in Duct Supports

4.4.1 (a7) Insulated with duct insulation as prescribed in Duct Insulation

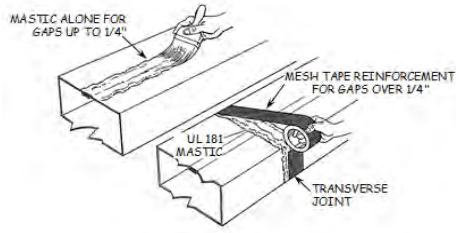


FIG. 8-2: SEALING WITH MASTIC

4.4.1 (b) Ducts installed within a closet or room shall be enclosed within a cavity constructed of materials equivalent to those used in the construction of the closet/room.

4.4.1 (c) A building cavity shall not be used as a duct without a sealed duct board or metal liner.

4.4.2 When missing, a damper shall be installed to separate an FAU that shares ducts with an evaporative cooler.

4.5. Duct Sealing and Repairs

4.5.1 Preparation

4.5.1 (a) The surrounding insulation will be cleared to expose the joints being sealed.

4.5.1 (b) The duct surface to which sealant will be applied will be cleaned.

4.5.1 (c) Debris and dirt will be cleaned out of the return platform.

4.5.2 Duct Core Repairs

4.5.2 (a) Holes or damage in the duct core shall be repaired by:

4.5.2 (a1) Removal of the damaged section and

4.5.2 (a2) Insertion of a new sleeve/coupling

4.5.3 Visible Leaks

4.5.3 (a) Gap size and approved sealing materials

4.5.3 (a1) A catastrophic leak (i.e., crushed, damaged, or destroyed duct) shall be repaired with a new section of duct of the same type as the rest of the system, whenever possible, and a new fitting.

4.5.3 (a2) Gaps in existing ducts shall be sealed in accordance with Table 8-2 and the subsequent standards.

TABLE 8-2: GAP SIZE AND APPROVED SEALING MATERIALS

Gap Size	Flexible Metallic & Non-Metallic Duct	Rigid Metal & Rigid Fiberglass Duct
≤¼"	Mastic or metallic tape	Mastic or metallic tape
>¼"—<1"	Replace duct and/or fitting with proper size. Edges or gaps shall be sealed with metallic tape or mastic.	Seal with mesh and mastic or Seal with mastic over tape
1" or wider	Replace duct and/or fitting with proper size. Edges or gaps shall be sealed with metallic tape or mastic.	Seal with a sheet metal patch/sleeve + mastic or metallic tape

4.5.4 Sheet Metal Patches

4.5.4(a) Installation (Fig. 8-3)

4.5.4(a1) Patch material shall match the existing duct material (i.e., galvanized patch for galvanized duct or aluminum patch for aluminum duct).

4.5.4(a2) The gauge of the patch should equal or exceed the gauge of the existing duct.

4.5.4(a3) Patch material shall extend at least 1" beyond each edge of the gap and overlap itself by at least 1".

4.5.4(a4) The patch shall be mechanically secured in compliance with Mechanical Fasteners.

4.5.4(a5) All patch edges/gaps shall be sealed with mastic or metallic tape.

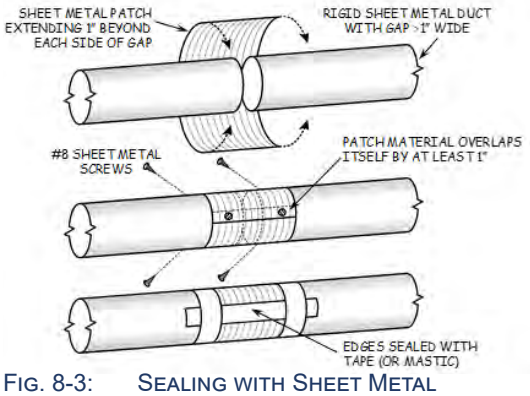


FIG. 8-3: SEALING WITH SHEET METAL PATCHES

4.5.5 Sealing with Mastic Reinforced with Mesh

4.5.5(a) Embed mesh fabric between two layers of duct mastic to form a mastic closure system.

4.5.5(a1) Center the first layer of mastic over the joint or gap to be sealed.

4.5.5(a2) Extend the mastic at least 1" onto each of the joined surfaces.

4.5.5(a3) Apply at least one layer of mesh over the entire joint or gap.

4.5.5(a4) Ensure the mesh is wrapped around the entire circumference where two sections of duct are joined together.

4.5.5(a5) Apply a second layer of mastic covering the mesh and at least 1" beyond the width of the mesh.

4.5.5(b) Internally applied mastic (core-to-fitting joints)

4.5.5(b1) Mastic coating applied inside the duct core or onto the rigid component over which the core is installed shall be at least ⅛" thick and 2" wide (Fig. 8-4).

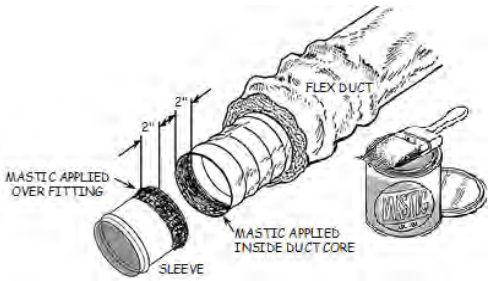


FIG. 8-4: MASTIC APPLIED OUTSIDE THE SLEEVE AND INSIDE THE DUCT

4.5.6 Sealing with Metallic (Pressure-Sensitive) Tape

4.5.6(a) Use at least three wraps of tape for:

4.5.6(a1) Joints at splices/connections in metal ducts

4.5.6(a2) Flexible duct core-to-fitting attachments in combination with a drawband to secure the core

4.5.6(a3) Jacket (vapor barrier) splices on flexible ducts

4.5.6(b) Overlap the tape by 50–75% of the tape width for each successive wrap.

4.5.7 Mechanical Fasteners

4.5.7(a) Rigid metal duct connections shall be secured with equally spaced sheet metal screws in accordance with the duct type below:

4.5.7(a1) Round ducts:

- Three screws on diameters up to 14"
- Four screws on diameters 15"–19"
- Five screws on diameters 20"–24"

4.5.7(a2) Rectangular ducts: At least one screw per side.

4.5.7(a3) Lapped seams (field-fabricated metal plenums, etc.):

- Overlapped surfaces shall be in substantial contact with each other along the entire seam and mechanically fastened at intervals of ≤12".
- Where the patch overlaps itself, at least one screw shall be installed on each side of the gap.
- At least two more screws shall be evenly spaced around the duct on each side of the gap.

4.5.7(b) Duct board plenum to air handler cabinet:

4.5.7(b1) The termination bar or metal strip will be fastened with screws.

4.5.7(b2) Duct board will be installed between the screw and the termination bar.

4.5.7(c) Boot to gypsum

4.5.7(c1) The boot hanger will be fastened to the adjacent framing with screws or nails.

4.5.7(c2) The boot will be connected to the boot hanger with screws.

4.5.7(c3) Integral snap boots will be installed.

4.6. Sealing Flexible Non-Metallic Ducts

4.6.1 Sheet Metal Collars and Sleeves for Flexible Non-Metallic Ducts

4.6.1(a) When ducts are joined, new fittings shall be beaded at both ends

4.6.1(a1) Sleeves must be at least 6" long

4.6.1(a2) Sheet metal collars shall be at least 4" long

4.6.1(b) When re-securing an existing fitting and the existing fitting is not beaded, the core's wire coil shall be secured mechanically to the fitting.

4.6.2 Sealing at Duct Fittings (Ells, Tees, Reducers) for Flexible Non-Metallic Ducts

4.6.2(a) Beaded fittings—Mastic

4.6.2(a1) A uniform coat of mastic must be applied to the outside of the fitting (Fig. 8-5).

4.6.2(a2) At least 2" of duct core must be pulled onto the fitting extending past the bead.

4.6.2(a3) A drawband (or metal clamp) shall be installed behind the bead.

4.6.2(a4) Mastic shall be applied externally to the thickness needed to ensure a complete seal.

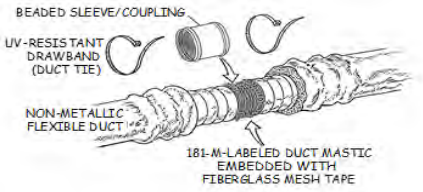


FIG. 8-5: BEADED FITTINGS WITH MASTIC SEALING

4.6.2(b) Beaded fittings—Metallic tape

4.6.2(b1) At least 1" of duct core must be pulled onto the fitting extending past the bead.

4.6.2(b2) A drawband (or metal clamp) is installed behind the bead.

4.6.2(b3) The connection shall be sealed with at least two overlapping wraps of metallic tape applied uniformly over both the core and the fitting.

4.6.2(c) Non-beaded pre-existing fittings—All sealants

4.6.2(c1) When an existing fitting is not beaded, the core's wire coil shall be secured to the fitting.

4.6.2(c2) The duct core must be secured to the fitting with internally placed mastic and a drawband or

4.6.2(c3) The duct core's wire coil must be mechanically secured to the fitting with at least three evenly spaced sheet metal screws that capture the wire.

- Metallic tape shall be applied to the duct core to prevent it from tearing, then sheet metal screws must be installed and penetrate the metallic tape.
- The connection shall be sealed with duct mastic or two overlapping wraps of metallic tape.

4.7. Sealing Rigid Ducts

4.7.1 Leaks at Crimp Joints in Rigid Metal Ducts

4.7.1(a) Seal all joints (contact laps) to be airtight.

4.7.1(b) Crimp joints (e.g., connection of duct to fitting or two sections of duct) shall overlap at least 1½", be mechanically fastened with at least three evenly spaced sheet metal screws, and be sealed with mastic or tape (Fig. 8-6).

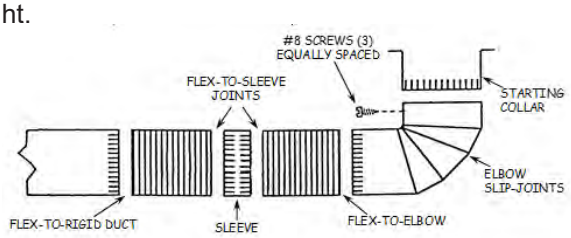


FIG. 8-6: OVERLAPPED SEAMS AND MECHANICAL FASTENERS

4.7.1(b1) A uniform coat of mastic shall be applied to the outside of the sleeve/fitting before the duct core is pulled on and added externally to ensure a complete seal or

4.7.1(b2) The connection shall be sealed with at least two overlapping wraps of tape applied uniformly over both the core and the fitting.

4.7.2 Damaged Rigid Ducts

4.7.2(a) Repair damaged ducts using materials from Table 8-2.

4.7.2(b) Mechanically attach with screws at intervals close enough that gaps do not occur.

4.7.2(c) Seal with mastic or metallic tape.

4.8. Sealing at Register Boots

4.8.1 Boot-to-Duct Connection

4.8.1(a) The duct shall be secured and sealed as prescribed above for each duct type (Fig. 8-7).

4.8.2 Boot-to-Interior Surface

4.8.2(a) All gaps between boot and interior surface that defines conditioned space will be air sealed.

4.8.2(b) The gypsum edge will be wetted before water-based sealant is applied.

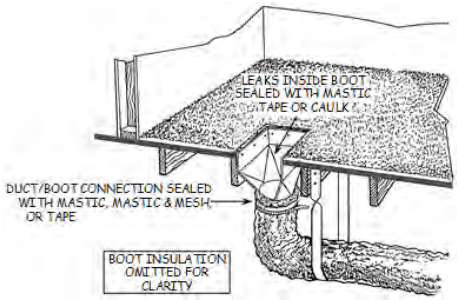


FIG. 8-7: REPAIR OF LEAKS IN BOOT

4.8.3 Leaks in the Boot

4.8.3(a) Gaps shall be sealed (Fig. 8-7) as prescribed above for repairing and sealing metal ducts.

4.8.3(b) Boot sealing material shall not interfere with the removal and replacement of the register.

4.8.4 Boot-to-Floor/Wall/Ceiling Connection

4.8.4(a) The boot shall be mechanically fastened to the structure and shall not rely on the duct for support or stability (Fig. 8-8).

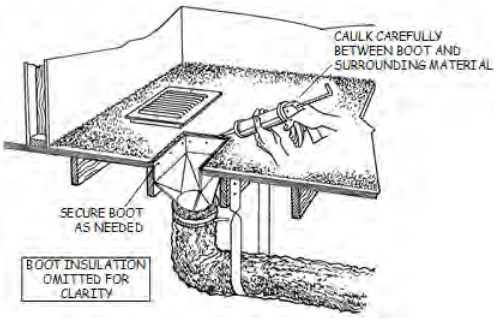


FIG. 8-8: BOOT-TO-FLOOR CONNECTION

4.8.4(b) Gaps between the boot and the surrounding material shall be sealed based on material to be used and gap size:

4.8.4(b1) ≤⅜": Elastomeric caulk

4.8.4(b2) 7⁄16"–⅝": Elastomeric caulk supported by backer rod

4.8.4(b3) ≤¼": Duct mastic or metallic pressure-sensitive tape

4.8.4(b4) >¼"–<1": Duct mastic reinforced with fiberglass mesh, or metallic tape covered with mastic

4.8.4(c) Sealants applied to the boot shall not interfere with the removal and replacement of the register.

4.9. Sealing at Refrigerant Lines

4.9.1 Cork tape shall be used for sealing gaps where air conditioning refrigerant lines penetrate the coil box/plenum.

4.10. Sealing Building Cavities

4.10.1 Required Sealing and Approved Sealants in Accordance with Table 8-2

4.10.1(a) Building cavities being used as ducts (e.g., platform return, panned joists, cabinet toe-kick supply terminal, etc.) shall be sealed in all accessible locations.

4.10.1(b) Sheet metal or fiberglass duct board must be used to line the cavity.

4.10.1(c) An insulated duct may be installed in lieu of lining/sealing the platform to connect the return grille to the FAU.

4.11. Correction of an Unlined/Unsealed Plenum

4.11.1 Accessible leaks in the plenum shall be sealed first in accordance with Table 8-2, then the plenum shall be insulated.

4.11.1(a) Fill stud cavities inside the plenum with flexible insulation, then line/seal them with sheet metal or

4.11.1(b) Install fiberglass duct board to both seal and insulate the plenum

4.11.2 When lining/sealing the platform is not feasible, an insulated duct may be installed to connect the return grille to the FAU.

4.11.3 Platform Plenum Sealing and Insulation

4.11.3(a) Seal unlined platform cavities as catastrophic leaks (billed as a duct sealing measure).

4.11.3(b) Foam board, foam sealants, and gypsum wallboard shall not be used.

4.11.3(c) Approved repair/liner materials include sheet metal and fiberglass duct board.

4.11.3(d) Permitted insulation of the plenum platform includes:

4.11.3(d1) Flexible insulation (batts) when the plenum will be lined with sheet metal or

4.11.3(d2) Fiberglass duct board for lining and insulation

4.12. Duct Supports

4.12.1 Flexible Ducts

4.12.1(a) Straps and other means of support shall not constrict the duct below its rated internal diameter or cut into the duct jacket or insulation.

4.12.1(b) The type of support strap may be restricted based on the requirements in the Material Specifications.

4.12.1(c) Support saddles shall fit neatly around and cover the lower half (180°) of the duct.

4.12.1(c1) The duct may rest on ceiling joists or truss members (Fig. 8-9) if:

- Support spacing and sag limitations are met
- The duct is not wedged between truss members

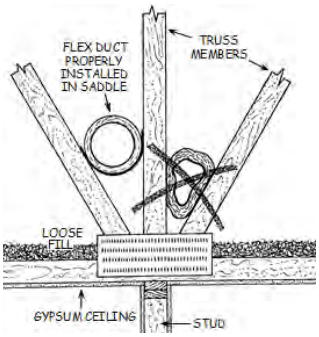


FIG. 8-9: SUPPORT OF FLEXIBLE DUCTS

4.12.1(d) Termination devices (e.g., register boots) shall be properly secured and shall not rely upon the duct for support.

4.12.1(e) Non-metallic support straps and anchors

4.12.1(e1) At each end, at least 2" shall be folded over and secured by two or more anchors that penetrate both layers of strap material.

4.12.1(f) Horizontal flexible ducts

4.12.1(f1) Spacing between supports shall be 4' maximum.

4.12.1(f2) Sag shall be no more than:

- ½" per foot of distance between supports
- 2" total between supports

4.12.1(f3) See Fig. 8-10.

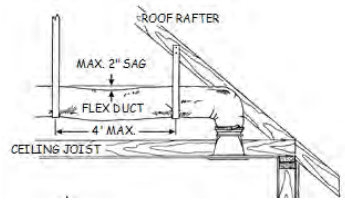


Fig. 8-10: Supports for Horizontal Flex Ducts

4.12.1(g) Vertical flexible ducts

4.12.1(g1) Spacing between supports shall be 6' maximum.

4.12.2 Rigid Round Metal Ducts

4.12.2(a) Horizontal installations

4.12.2(a1) Spacing between supports shall be 10' maximum.

4.12.2(a2) Support shall tightly encircle the duct.

4.12.2(b) Vertical installations

4.12.2(b1) Spacing between supports shall be 10' maximum.

4.12.3 Rigid Rectangular Metal Ducts

4.12.3(a) Horizontal installations

4.12.3(a1) Spacing between supports shall be 4' minimum to 10' maximum.

4.12.3(a2) Support straps shall be secured to the sides of the duct with sheet metal screws, rivets, or bolts.

4.12.3(b) Vertical installations

4.12.3(b1) Spacing between supports shall be 10' maximum.

4.12.4 Rigid Fiberglass Ducts

4.12.4(a) Spacing between supports shall be 10' maximum.

4.12.5 Horizontal Plenums (Metal and Fiberglass Duct Board)

4.12.5(a) The plenum shall:

4.12.5(a1) Not rely on the furnace for support

4.12.5(a2) Be independently supported at each end

4.12.5(a3) Be supported in 4' intervals if over 10' in length

4.13. Duct Jacket Repair

4.13.5(a) Duct jacket (vapor barrier) (Fig. 8-11)

4.13.5(a1) The duct insulation shall completely cover all duct core and fitting.

4.13.5(a2) Rips and holes in the jacket shall be repaired with metallic tape or with mastic and mesh.

4.13.5(a3) A duct jacket shall cover all exposed insulation.

- Jackets must overlap at least 2" at duct splices.
- Jackets shall be secured/sealed with a drawband and/or two overlapping wraps of metallic tape.

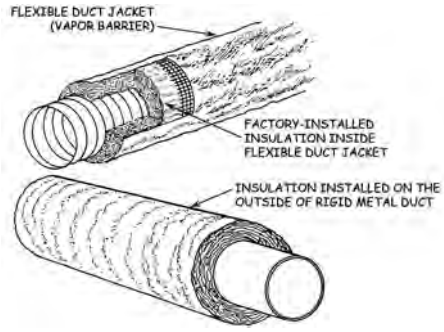


Fig. 8-11: Duct Jacket—100% Coverage Required

4.14. Duct Insulation

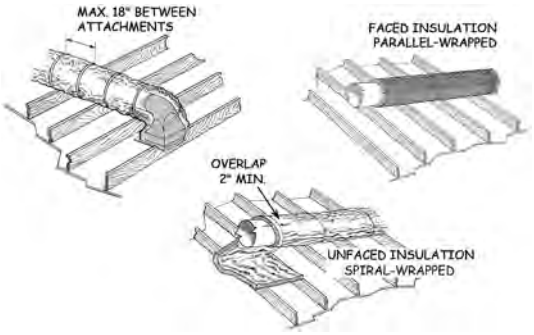


Fig. 8-12: Duct Insulation Installation

4.14.1 Uninsulated ducts shall be insulated after all duct repairs and sealing are completed (Fig. 8-12).

4.14.2 Coverage and R-Value

4.14.2(a) All uninsulated ducts, air connectors, plenums, distribution boxes, and system components shall be insulated according to Material Specifications.

4.14.3 Compression

4.14.3(a) Supports shall not compress duct insulation more than 20% overall.

4.14.3(b) Duct insulation shall not be compressed more than 50% on corners/bends.

4.14.4 Clearances

4.14.4(a) Combustion air vents shall not be obstructed by duct insulation.

4.14.4(b) Combustible facings and attachments:

4.14.4(b1) 6" clearance from single-wall gas vent pipes

4.14.4(b2) 1" clearance or the clearance specified by the listing, whichever is greater, for listed Type B double-wall gas vent pipes

4.14.4(b3) 3" clearance from all other heat-producing devices (HPDs)

4.14.5 Attachment of Rigid Fiberglass Insulation

4.14.5(a) Insulation shall be securely attached (e.g., with stickpins).

4.14.5(b) Insulation seams shall be sealed with metallic tape (Underwriters Laboratories [UL] 181A-P type only) or mastic reinforced with mesh tape (UL 181A-M type only)

4.14.6 Installation of Flexible Insulation

4.14.6(a) Installation method:

4.14.6(a1) Spiral-wrapped

- Wraps of unfaced insulation shall overlap each other at least 2".
- Insulation shall be mechanically secured (e.g., with drawbands, wire, nails, or staples) as needed to prevent gaps or openings.

4.14.6(a2) Parallel-wrapped

- Faced wraps shall be secured and sealed with pressure-sensitive tape or as prescribed by the manufacturer. When metallic (pressure-sensitive) tape is used, it shall be wrapped a minimum of three times around the circumference.
- Unfaced wraps shall be mechanically secured with fasteners (drawbands, wire, nails, or staples) installed no more than 18" apart along the lengthwise seam (overlap) of the insulation.

4.14.7 Exposed Ducts in Habitable Spaces

4.14.7(a) When fiberglass insulation is installed, it shall be faced.

4.14.7(b) Fiberglass edges shall not be left exposed in the living space

4.15. Pressure Balancing

4.15.1 Room-to-room pressures shall be balanced to provide adequate air movement throughout the living space with interior doors closed per Appendix B Duct Leakage Testing Protocol.

4.15.2 Proper airflow and a pressure difference of ≤3 pascals (Pa) shall be provided for each room containing a supply or a return utilizing one of the following methods:

4.15.2(a) An unclosable grille that provides a net free ventilation area (NFVA) equal to at least 1 sq. in. for every 5 sq. ft. of total living area in the room may be installed in the door or wall.

4.15.2(b) The door may be undercut by a maximum of 2½".

4.15.3 The pressure system balance shall be checked and modifications shall be made as needed to provide proper airflow and room pressures.

5. MOBILE HOME–SPECIFIC

5.1 Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

5.2. Duct System Inspection and Analysis

5.2.1 Mobile Home Duct System Pre-Inspection

5.2.1(a) Supply registers and return grilles shall be removed to facilitate system inspection and the performance of repair/sealing work (Fig. 8-13).

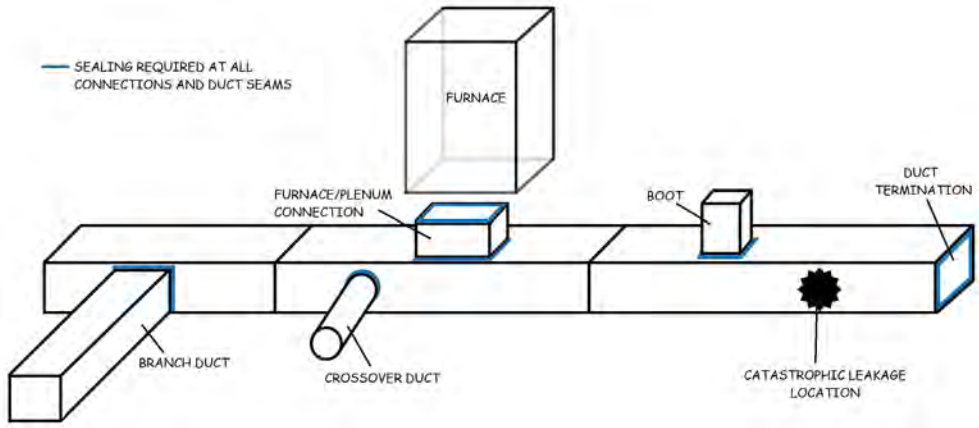


FIG. 8-13: DUCT SYSTEM WITH COMMON LEAKAGE AREAS—MOBILE HOME

5.2.1(b) A mirror and light shall be used to perform inspection of:

5.2.1(b1) Joints and connections in the boot and riser

5.2.1(b2) The duct termination (dead end) at the register nearest the end of each duct run

5.2.1(b3) Each duct run to locate leaks, disconnections, and other defects

5.2.1(b4) The duct connector under the furnace, when accessible

5.3. Correction of Catastrophic Leaks

5.3.1 Install new (replaced) duct to correct crushed, damaged, disconnected, or missing duct or a belly return (Fig. 8-14).

5.3.1(a) When installed, new duct runs shall be sized, installed, and connected as prescribed in this section and in Housing and Urban Development (HUD) Manufactured Home Construction and Safety Standards (MHCSS) Part 3280.715.

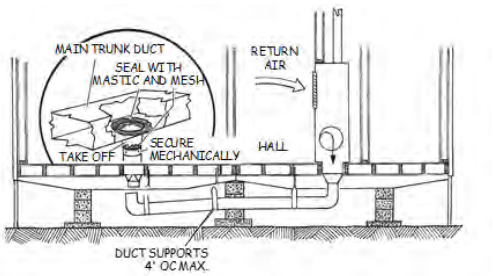


FIG. 8-14: REPAIR OF A DAMAGED CROSSOVER DUCT IN A MOBILE HOME

5.3.2 Replacing a Central Return

5.3.2(a) An existing belly or roof cavity return for an upflow or downflow furnace shall be abandoned (Fig. 8-15 and Fig. 8-16). A new ducted central return shall be installed, supported, and sealed.

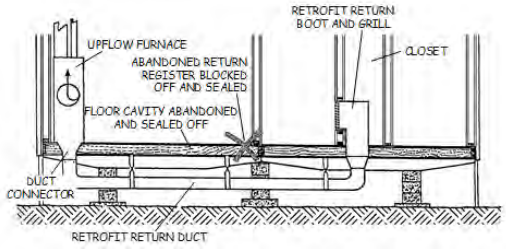


FIG. 8-15: CENTRAL RETURN INSTALLATION AND ABANDONED BELLY CAVITY RETURN

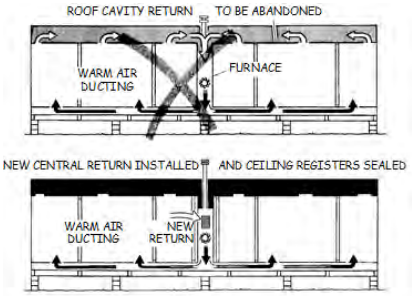


FIG. 8-16: ROOF CAVITY RETURN REPLACED BY CENTRAL RETURN

5.3.2(b) Existing return air openings will be closed off and sealed with a durable material equivalent in strength to the surrounding material.

5.3.2(c) Return duct design will be in accordance with American National Standards Institute [ANSI]/Air Conditioning Contractors of America Association, Inc. [ACCA] 1 Manual D Residential Duct Systems.

5.3.2(d) The return grille shall be:

5.3.2(d1) Sized to provide a minimum of 2 sq. in. of NFVA for each 1,000 Btuh furnace capacity

5.3.2(d2) Installed in the outside wall of a closet when possible, or in the floor when necessary

5.3.2(d3) Located in a hallway or other open area

5.3.2(d4) Centrally located within the mobile home

5.4. Mobile Home Duct Sealing and Repair

5.4.1 Risers

5.4.1(a) Risers that are loose or are disconnected from the trunk shall be reattached, secured, and sealed (e.g., with metallic tape) (Fig. 8-17).

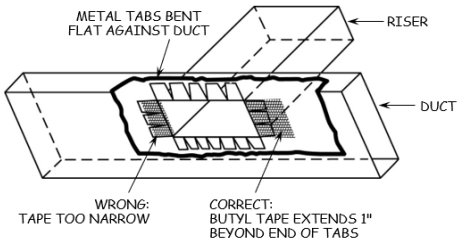


FIG. 8-17: PREPARE AND SEAL JOINT BETWEEN RISER AND TRUNK DUCT

5.4.2 Metal Overlaps/Tabs

5.4.2(a) Metal overlaps/tabs at the joint between the riser and the trunk duct shall be repaired and permanently sealed (e.g., with metallic tape).

5.5. Application of Duct Sealant

5.5.1 Dust, dirt, and failed existing sealant shall be removed from surfaces where sealant will be applied.

5.5.2 Metal overlaps/tabs shall be bent as needed to achieve metal-to-metal contact.

5.5.3 Joint overlaps/tabs shall be sealed with:

5.5.3(a) Metallic tape (e.g., 3" wide) or

5.5.3(b) Duct mastic and fiberglass mesh

5.5.4 Sealant must cover all overlaps/tabs and extend approximately 1" beyond the ends of the overlaps/tabs.

5.5.5 If not loose, existing metallic tape shall be covered with new sealant to achieve a permanent seal.

5.6. Sealing from Registers

5.6.1 Duct Interiors

5.6.1 (a) Visible leaks that can be reached through the register opening shall be sealed utilizing materials and methods prescribed for conventional homes.

5.6.1 (a1) Such leak types may include:

- Duct joints/splices and other loose metal overlaps
- Duct terminations (dead ends)
- Leaks in the duct connector underneath the furnace (accessed through a removable bottom panel on the front of the unit)

5.7. Sealing at Duct Terminations

5.7.1 Duct Termination

5.7.1 (a) A duct termination (dead end) (Fig. 8-18) shall be:

5.7.1 (a1) Repaired and sealed or

5.7.1 (a2) Securely blocked (e.g., with a sheet metal dam or fiberglass duct board dam) and permanently sealed

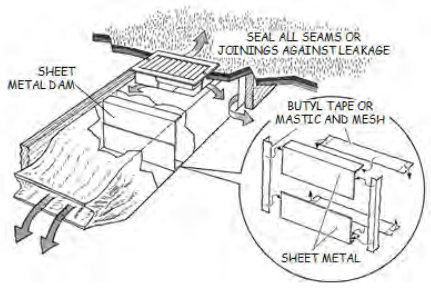


FIG. 8-18: SHEET METAL DAM

5.7.2 Dam Installation

5.7.2 (a) Dams shall be:

5.7.2 (a1) Placed as far from the register opening as possible

5.7.2 (a2) Mechanically attached whenever possible

5.7.2 (b) Dams may be attached/sealed with:

5.7.2 (b1) Metallic tape or

5.7.2 (b2) Mastic and mesh tape

5.8. Sealing Ducted Returns

5.8.1 Rodent barrier (bellyboard) sections shall be removed for access as needed.

5.8.2 Accessible leaks shall be repaired.

5.8.3 Access holes made in the rodent barrier shall be repaired.

5.9. Crossover Ducts

5.9.1 Double-Wide Units

5.9.1 (a) Disconnections shall be reconnected, mechanically secured, and sealed.

5.9.1 (b) Other major leaks that are repairable shall be repaired and sealed as prescribed for conventional homes.

5.9.1 (c) Disconnected and damaged duct components that cannot be feasibly repaired shall be replaced.

5.9.2 Flexible Crossover Ducts

5.9.2 (a) Connections will be added, rebuilt, or repaired using compatible materials and will be:

5.9.2 (a1) Mechanically fastened at both the inner and outer liner

5.9.2 (a2) Sealed using UL-listed sealant that is durable, structurally sound, and insulated

5.9.2 (a3) Equipped with a vapor retarder

5.9.2 (b) Whenever possible, rigid elbow or equivalent will be installed in crawlspace crossover ducts.

5.9.2 (c) Floor insulation will be in contact with the outer liner of the crossover duct.

5.9.2 (d) Crossover duct vapor retarder will be sealed to the bottom liner (e.g., belly fabric).

5.9.2(e) When feasible, 26-gauge hard duct should be installed.

5.9.2(f) If a new crossover is required, it must be insulated to at least R-8 and be air sealed.

5.9.3 Crossover Duct Support

5.9.3(a) Crossover ducts will be:

5.9.3(a1) Installed so they are not in contact with the ground

5.9.3(a2) Supported in accordance with flex duct manufacturer specifications and local codes

5.9.3(b) Support materials will be applied in accordance with manufacturer specifications for interior dimensions and will not crimp ductwork, dip, or sag.

5.9.4 Through-the-Rim Crossover Ducts

5.9.4(a) Through-the-rim crossover ducts will be located and accessed through the bottom liner and branch duct. All branch crossover duct connections and end caps will be located and accessed.

5.9.4(b) The duct size between the branch crossover and the trunk will be maximized.

5.9.4(c) All connections will be mechanically fastened and sealed inside duct.

5.9.4(d) End caps will be sealed.

5.9.4(e) Access holes in the trunk duct will be repaired and sealed.

5.9.4(f) Insulation will be reinstalled.

5.9.4(g) The bottom liner/belly will be repaired.

5.9.5 Attic Crossover Ducts

5.9.5(a) Where feasible, access to the attic will be created for all attic areas that contain crossover ducts.

5.9.5(b) Plenum boxes and crossover duct connections will be rebuilt, mechanically fastened, and sealed.

5.9.5(c) Access holes will be repaired.

5.9.6 Performance Testing

5.9.6(a) Pre- and post-retrofit duct leakage will be performance tested using a duct blaster or pressure pan, and the results will be documented in the file and reported to the homeowner.

5.10. Rodent Barrier (Bellyboard) Repair

5.10.1 Holes in the bellyboard created to access ducts from underneath the mobile home shall be repaired.

5.10.1(a) All holes shall be repaired with a material equivalent or superior to that of the existing bellyboard (Fig. 8-19).

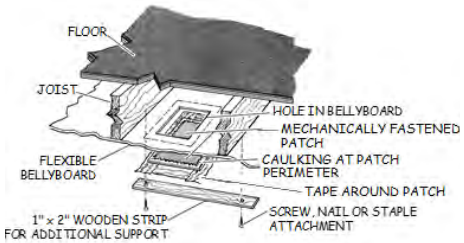


FIG. 8-19: LAYERED METHOD FOR PATCHING RODENT BARRIER

5.10.2 Patches in Flexible Rodent Barrier

5.10.2(a) All patches shall be secured and sealed by means of self-adhesive backing or caulk/adhesive sealant.

5.10.2(b) Patches shall be mechanically secured as needed to ensure permanence by one or more of the following means:

5.10.2(b1) Outward clinch (“stitch”) staples, or equivalent, positioned to permanently and securely attach the patch directly to the existing bellyboard

5.10.2(b2) Fasteners penetrating the wooden joists a minimum of ½" and spaced a maximum of 4" on center (OC)

5.10.2(b3) Wooden strips (e.g., attached with screws into floor joists or adjacent girders)

5.10.2(c) Sealant shall be placed around the perimeter of the patch to ensure a complete and permanent seal.

5.10.3 Patches in Rigid Rodent Barrier

5.10.3(a) Patches shall be mechanically secured, and the perimeter shall be sealed with suitable caulk/adhesive sealant.

5.10.3(b) Approved mechanical attachments include:

5.10.3(b1) Fasteners penetrating the wooden joists a minimum of ¾" and spaced a maximum of 6" OC

5.10.3(b2) Wooden strip supports spanning beyond the patch and secured mechanically into the framework above

5.10.3(b3) A combination of methods that will provide a stable, permanent seal

5.10.3(c) For small patches in high-density material, it is acceptable to secure fasteners into the existing bellyboard only.

5.10.4 Missing or damaged skirting shall be replaced per Section 1 General Installation Guidelines, Limited Home Repair.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 Independent FAU

6.1.1(a) When an individual dwelling unit has an independently operating FAU and duct system in a multi-family building, installation requirements are the same as those for conventional homes.

6.1.2 Common System (Serving Multiple Dwelling Units)

6.1.2(a) When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.2(a1) Installation (e.g., repair and sealing of duct systems within the same thermal boundary as dwelling units) is allowed when justified by an energy audit for a whole-building project, per Appendix D Energy Audit/Priority List Protocol.

6.1.3 When the duct system is not accessible (e.g., ducts are located between floors), this measure is not feasible.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 Duct leakage testing and sealing, and inspector retesting, are required on 100% of units for which DOE funds are used, or the dwelling must be deferred.

7.1.2 Duct testing shall be conducted in accordance with Appendix B Duct Leakage Testing Protocol.

7.1.3 To assess for this Duct Sealing and Duct Insulation as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.3(a) The form will determine if the measures will be installed in the Audit path or the Priority List (PL) path.

7.1.3(b) When assessing for this measure for the Audit path, measure feasibility will be decided by the energy audit with a Measure savings-to-investment ratio (SIR) and Dwelling SIR.

7.1.3(b1) When a measure is feasible based on the audit, and the measure is categorized as a “Major” measure (i.e., Infiltration Reduction, Duct Sealing, Ceiling Insulation, Floor Insulation, and Wall Insulation), it shall be installed or the dwelling must be deferred.

7.1.3(c) When assessing for the Duct Sealing and Duct Insulation measures in the PL path, the feasibility will be based on building type and characteristics.

7.1.3(c1) PL measures are classified as Mandatory or Optional based on building type.

- Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.
- Optional measures may be installed only after all feasible Mandatory PL measures have been installed.

7.1.4 When this measure is fully leveraged or co-funded with LIHEAP, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/ Priority List Protocol.

7.1.5 If a client refuses a feasible Audit path Major measure, Mandatory Priority List path, or Health & Safety measure, the entire dwelling shall be deferred.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2(a) Excerpted from 2017 SWS 3.1601.1:

7.2.2(a1) [Duct board-to-duct board] joints will be fastened with clinch stapler and c-channels if possible.

7.2.2(b) Excerpted from 2017 SWS 3.1602.1:

7.2.2(b1) New component-to-existing component:

- Seams, cracks, joints, holes, and penetrations less than ¼" will be sealed using fiberglass mesh and mastic.
- Mastic alone will be acceptable for holes less than ¼" that are more than 10' from air handler.
- Seams, cracks, joints, holes, and penetrations between ¼"–¾" will be sealed in two stages:
  - They will be backed using temporary tape (e.g., foil tape) as a support prior to sealing.
  - They will be sealed using fiberglass mesh and mastic.

7.2.2(b2) Existing component-to-existing component

- Seams, cracks, joints, holes, and penetrations less than ¼" will be sealed using UL 181 fiber-embedded mastic
- Seams, cracks, joints, holes, and penetrations between ¼" and ¾" will be sealed in two stages:
  - They will be backed using temporary tape (e.g., foil tape) as a support prior to sealing. They will be sealed using fiberglass mesh and mastic.
  - Seams, cracks, joints, holes, and penetrations larger than ¾" will be repaired using rigid duct material.
  - Mastic will overlap repair joint or existing temporary tape by at least 1" on all sides.

7.2.2(c) Excerpted from 2017 SWS 3.1602.4:

7.2.2(c1) Accessible connections and joints will be made airtight using approved material.

7.2.2(d) Excerpted from 2017 SWS 4.1601.5:

7.2.2(d1) Duct insulation will be a minimum of R-8, in accordance with local code or buried under attic insulation, whichever is a greater R-value, and have an attached and continuous vapor barrier.

7.2.2(d2) Hot humid and warm coastal regions will not bury ducts.

7.2.2(e) Any ducts exposed to weather will be insulated to a minimum of R-12.

7.2.3 Mobile Home

7.2.3(a) Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

7.2.3(b) Excerpted from 2017 SWS 3.1601.5:

7.2.3(b1) For oval flexible duct to metal connections, tie bands cannot be used; appropriate mechanical fastener will be used.

7.2.3(b2) Metal take-off collar specifically designed for the thickness of the duct board will be used.

7.2.3(b3) Sealing duct board to flexible duct

- Metal take-off collar specifically designed for the thickness of the duct board will be used.
- All finger tabs will be bent down securely.
- Finger tabs will be longer than the thickness of the duct board and the shank will not extend beyond the thickness of the duct board.
- There will be an internal metal backer inside the duct board through which three evenly spaced screws can be secured; the metal backer will not interfere with air flow.

7.2.3(b4) Duct board plenum-to-air handler cabinet

- Flange/c-channel will be fastened with screws with the duct board installed between c-channel flanges.
- Duct board plenum will be connected to air handler plenum with flexible duct in upflow units.
- Pre-drill for screws or use ring shanked nails to fasten boot to wood.
- If accessible, boot hanger will be fastened to adjacent framing with screws or nails.
- If inaccessible, boot will be fastened to gypsum with a durable, adhesive sealant.
- Metal take-off collar with a hip and an internal metal backer will be used.

7.2.3(c) Excerpted from 2017 SWS 3.1602.8:

7.2.3(c1) Floor will be prepared to receive the appropriately sized plenum.

7.2.3(c2) Plenum will be rebuilt or repaired using compatible materials and will be:

- Mechanically fastened
- Sealed
- Durable
- Structurally sound
- Insulated
- Equipped with a vapor retarder where climate appropriate

7.2.3(c3) If possible, flow diverter or turning vanes will be installed for air flow and/or balancing (e.g., bullhead Ts, offset air handler).

7.2.3(c4) Point of access options include:

- Option 1: Through the trunk duct
  - Repair and seal access hole in the trunk duct
  - Install insulation
  - Repair belly/bottom liner
- Option 2: Remove crossover duct
  - Reattach crossover duct
  - Seal and insulate crossover duct
  - Repair belly/bottom liner

- Option 3: Remove air handler
  - Install new gasket, if necessary
  - Mechanically attach furnace to the structure
  - Reconnect utilities
  - Replace and seal panels
- Option 4: Through the furnace panel
  - Replace and seal panels

7.2.3(c5) Equipment will be cycled.

7.2.3(d) Excerpted from 2017 SWS 3.1602.10:

7.2.3(d1) Access holes will be created for the work done at each location.

7.2.3(d2) Excess flex duct will be removed between the takeoff at trunk and floor register boot.

7.2.3(d3) Hard and flex duct branch connections will be rebuilt or repaired using compatible materials and will be mechanically fastened and sealed.

7.2.3(d4) Ends will be sealed.

7.2.3(d5) Access hole in the trunk/branch duct will be repaired and sealed.

7.2.3(d6) Insulation will be reinstalled.

7.2.3(d7) Bottom liner/belly will be repaired.

7.2.3(e) Excerpted from 2017 SWS 4.1601.2:

7.2.3(e1) All joints, seams, and connections in ductwork shall be securely fastened and sealed with UL 181 B-M mastics (adhesives) or mastic-plus-embedded-fabric systems installed in accordance with the manufacturer's instructions before insulation is applied.

7.2.3(f) Excerpted from 2017 SWS 5.3003.3:

7.2.3(f1) Proper air flow delivery to each room will be ensured by measuring air flow at each register or by measuring heat rise, room pressures, and interviewing residents to ensure their comfort.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Ensure the CSD 706 Duct Leakage Data Sheet is properly completed and duct sealing measures were properly performed.

8.1.2 Perform CAS testing in accordance with Appendix A Combustion Appliance Safety Protocol.

8.1.3 Retesting for duct leakage is required on a minimum of 20% of inspected units as part of the quality assurance post-inspection for LIHEAP units per Appendix B Duct Leakage Testing Protocol.

8.2. Client Education

8.2.1 The client shall be supplied with instructions for proper operation and maintenance of the measure installed, including:

8.2.1(a) The importance of not blocking inlets

8.2.1(b) The importance of cleaning dust and debris from return grilles

8.2.1(c) Proper placement of interior furnishings with respect to registers

8.2.1(d) Negative consequences of closing registers

8.3. Clean-Up and Disposal Requirements

8.3.1 Paint dust and chips, scraps, and other debris resulting from duct sealing and repair activities shall be cleaned up and removed from the premises utilizing lead-safe practices when applicable.

8.3.2 Furniture and other household items moved for installation work shall be returned to their original positions.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 Duct Repair and Sealing

9.1.1(a) LIHEAP: 10 years

9.1.1(b) DOE: 10 years

9.1.2 Duct Insulation

9.1.2(a) LIHEAP: 10 years

9.1.2(b) DOE: 20 years

9.2 Ducts and Component Materials

9.2.1 Materials shall comply with:

9.2.1(a) Current Title 24 Residential Compliance Manual, Chapter 4

9.2.1(b) Current California Mechanical Code (CMC), Chapter 6

9.2.2 Only exterior-rated ducts and components shall be used when installed outdoors or in weather-exposed areas.

9.2.3 Rigid Metal Duct and Sheet Metal Components

9.2.3(a) All rigid metal ducts, plenums, and metal components shall be of non-corrosive metal.

9.2.4 All Flexible Duct

9.2.4(a) Ducts shall conform to National Fire Protection Association (NFPA) 90B and UL 181 (Class 1).

9.2.4(b) Non-metallic insulated ducts with air-permeable core not allowed.

9.2.4(c) The duct jacket (vapor barrier) shall be made of ultraviolet (UV)-resistant material (e.g., silver metalized polyester jacket).

9.2.4(d) New fittings shall be used with new flexible non-metallic duct

9.2.4(d1) All new fittings shall be beaded at each core connection (e.g., both ends of a sleeve).

9.2.4(d2) Starting collars must be 4" installed length and made of 26-gauge galvanized steel (up to 14" diameter).

9.2.4(d3) Splicing sleeves must be 6" in length and made of 26-gauge galvanized steel (up to 14" diameter).

9.2.5 Rigid fiberglass ducts shall conform with UL 181 and the current CMC.

9.2.6 Duct Board

9.2.6(a) High-density fiberglass duct board shall conform with American Society for Testing and Materials (ASTM) C726, NFPA 90B, or UL 181 (Class 1).

9.2.6(b) Foam board is not allowed as a barrier material in the repair or sealing of building cavities used as ducts, platforms, or other duct system components.

9.3 Sealants

9.3.1 Approved sealants shall be UL-listed and labeled per Table 8-3.

9.3.2 Foam sealants shall not be allowed in the sealing of building cavities used as ducts, platforms, or other duct system components.

9.3.3 Mastics and Mesh

9.3.3(a) All approved mastics shall be UL-labeled and listed as identified in Table 8-3, non-toxic, water-resistant, and rated for exterior use.

9.3.3(a1) Outdoor applications must be rated for exterior applications.

9.3.3(b) At a minimum, mesh used to reinforce duct mastic shall be:

9.3.3(b1) Fiberglass material, 9 x 9 minimum weave per inch, and 0.006" thick

9.3.3(b2) 2" minimum width for use on flexible and rigid metal ducts

9.3.3(b3) 3" minimum width for use on rigid fiberglass ducts

TABLE 8-3: APPROVED DUCT SEALING MATERIALS

Duct Type	Sealing Material	UL Identification
Rigid metal and fiberglass duct and components	Metallic tape (pressure-sensitive)	Marked 181A-P or 181A-P/181B-FX
	Heat-activated tape	Marked 181A-H
	Mastic	Labeled 181A-M or 181A-M/181B-M
Flexible ducts	Metallic tape (pressure-sensitive)	Marked 181B-FX or 181A-P/181B-FX
	Mastic	Labeled 181A-M or 181A-M/181B-M

9.3.4 Metallic Tape

9.3.4(a) Cloth-backed rubber adhesive tapes are not permitted.

9.3.4(b) Approved metallic tapes shall be listed and marked in accordance with Table 8-3.

9.3.4(c) Other tapes may be used only for the specific applications described below:

9.3.4(c1) Flexible non-metallic and flexible metallic ducts

- Cloth-backed butyl-adhesive tapes may be allowed if California Electrical Code (CEC)–approved for use in California (i.e., indicated by “CA” in the product number).

9.3.4(c2) Rigid metal ducts and components

- Butyl tape without UL 181A-P or UL 181B-FX markings may be used to seal rigid metal-to-metal connections.

9.3.4(c3) Access panels

- Use metallic tapes with non-butyl (e.g., acrylic) adhesive.

9.3.4(c4) High-temperature applications

- Use metallic tapes with non-butyl (e.g., acrylic) adhesive and a service temperature rating of at least 265°F.

9.3.5 Caulking materials shall be:

9.3.5(a) Non-toxic

9.3.5(b) Selected and applied in accordance with Section 32 Infiltration Reduction

9.4 Mechanical Fastenings

9.4.1 Screws: #8 sheet metal screws shall be used.

9.4.2 Drawbands and Clamps (Duct Ties)

9.4.2(a) Drawbands shall:

9.4.2(a1) Be weather- and UV-resistant nylon duct ties rated for outdoor use

9.4.2(a2) Have a tensile strength rating of 150 lb.

9.4.2(a3) Be marked UL 181B-C

9.4.2(b) Drawbands must be tightened with an adjustable tensioning tool in accordance with the duct manufacturer's instructions.

9.4.2(c) Clamps shall be stainless steel worm-drive clamps.

9.5 Duct Supports

9.5.1 All Ducts

9.5.1(a) Support materials shall be corrosion-resistant and shall conform to the duct manufacturer's installation instructions, Title 24 Standards, and CMC Chapter 6.

9.5.2 Flexible Ducts (Horizontal and Vertical)

9.5.2(a) Non-metallic support straps:

9.5.2(a1) Polypropylene monofilament, woven polyester, polyester scrim–reinforced vinyl laminate, or equivalent

9.5.2(a2) Minimum width: 1¾"

9.5.2(a3) Minimum tensile strength: 70 lb. per inch of width

9.5.2(b) Sheet metal support straps and saddles

9.5.2(b1) Width: 1½" minimum

9.5.2(b2) Thickness: 26-gauge minimum

9.5.3 Rigid Ducts (Horizontal and Vertical)

9.5.3(a) Horizontal rigid round metal ducts

9.5.3(a1) Up to 10" diameter

- Galvanized steel straps, same gauge as duct, 1" minimum width or
- 18-gauge galvanized steel wire

9.5.3(a2) 11"–40" diameter

- Galvanized steel straps, same gauge as duct, 1" minimum width or
- 8-gauge galvanized steel wire tied to a galvanized steel band, 1" minimum width, surrounding the duct

9.5.3(b) Vertical rigid round metal ducts

9.5.3(b1) Up to 10" diameter

- 18-gauge galvanized steel straps, 2" minimum width

9.5.3(b2) 11"–20" diameter

- 16-gauge galvanized steel straps, 2" minimum width

9.6 Duct Insulation

9.6.1 Flame-spread index not to exceed 25 and smoke-developed index not to exceed 50 where tested in accordance with ASTM E84 or UL 723.

9.6.2 R-value shall be as shown in Table 8-4, or greater if required by local code.

TABLE 8-4: DUCT INSULATION MINIMUM R-VALUES

Climate Zone	Minimum R-Value
3, 5, 6, 7	R-6
1, 2, 4, 9 – 16	R-8

9.6.3 Approved Insulation Attachment Materials

9.6.3(a) Drawbands (duct ties)

9.6.3(b) Non-corrosive wire, 20-gauge minimum

9.6.3(c) Rust-resistant nails or staples

9.6.3(d) Metallic (pressure-sensitive) tape

9.7 Mobile Home–Specific Duct Materials

9.7.1 Where material specifications are not identified specifically for mobile homes, conventional home specifications shall apply.

9.7.2 The rodent barrier shall be composed of material equivalent or superior to the existing bellyboard.

9.7.3 When crawlspace ducts are accessible to animals, only internally insulated rigid metal ducts shall be used.

9.7.4 When crawlspace ducts are not accessible to animals, flexible ducts may be installed to:

9.7.4(a) Replace damaged or deteriorated ducts (e.g., crossover ducts)

9.7.4(b) Install a new ducted return system

9.7.5 All flexible ducts for mobile homes must:

9.7.5(a) Conform to NFPA 90B and UL 181 Class 1

9.7.5(b) Have duct insulation minimum thermal resistance (R-value) ≥4.2 (when required by local code)

9.7.5(c) Have vapor barrier material as described below:

9.7.5(c1) Rated for mobile home use (e.g., with HUD markings on the jacket)

9.7.5(c2) Minimum thickness of 3.5 mils

9.7.5(c3) Maximum permeance of 1.0 perm

9.7.6 Flexible Non-Metallic Ducts

9.7.6(a) Non-metallic flexible duct core shall be fabricated with a spring steel helix bonded within non-porous material (e.g., molded composite or two-ply lamination of polyester).

9.7.7 Flexible Metallic Ducts

9.7.7(a) Metallic flexible duct core shall be fabricated from minimum 0.0065" thick aluminum material or equivalent.

9.7.8 Rigid Metal Ducts

9.7.8(a) Only galvanized or aluminum ducts shall be allowed.

9.7.8(b) The gauge of any rigid metal duct patch shall equal or exceed the gauge of the existing duct.

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

9. Whole House Fans

Table of Contents

Whole House Fans

1. MEASURE OBJECTIVES

1.1 A whole house fan (WHF) brings in outside air through door and/or window openings and expels air through the attic vents to cool the living space.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 A functional central air conditioning system or a minimum of two window/wall air conditioning units exist in the home or

2.2.2 An existing WHF has one of the following operational issues:

2.2.2(a) Airflow is less than 1.5 cu. ft. per minute (CFM)/sq. ft. of conditioned floor area.

2.2.2(b) It has a hazard condition (such as an electrical hazard) that will be resolved by installing a new fan.

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 An existing WHF provides airflow of at least 1.5 CFM/sq. ft. of conditioned floor area

3.2 The required inlet air (open doors/windows) and/or exhaust air (attic venting net flow ventilation area) cannot be provided

3.3 An open combustion gas appliance with a standing pilot is in the house or attic, or other hazard per Appendix A Combustion Appliance Safety Protocol

3.4 Cutting of truss chord(s) or ceiling joists would be required for the installation

3.5 Attic access is not adequate and cannot be installed under Section 1 General Installation Guidelines, Limited Home Repair

3.6 No feasible location is available with sound structural framing and adequate clearances

3.7 A proper grounded electrical circuit is not present and cannot be installed

3.8 Installation would violate the Appendix E Health and Safety Requirements

3.9 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 The WHF shall be one of these three types:

4.1.1(a) Ceiling-mount with barometric shutter

4.1.1(b) Ducted remote fan

4.1.1(c) Ceiling-mount with insulated top cover

4.1.2 Combustion appliances that may be affected by the WHF shall be tested in accordance with Appendix A Combustion Appliance Safety Protocol to ensure proper operation.

4.1.3 Window Screens

4.1.3(a) Windows, sliding glass doors, and screen doors on entry doors used to provide ventilation during WHF operation shall have intact insect screens.

4.1.3(a1) Damaged or missing screens shall be repaired or replaced under Section 1 General Installation Guidelines, Limited Home Repair.

4.1.4 Structural Integrity

4.1.4(a) Framing members shall be structurally sound and suitable for the installation.

4.1.5 Attic Exhaust Ventilation

4.1.5(a) Exhaust ventilation net free ventilation area (NFVA) for WHF shall:

4.1.5(a1) Comply with the WHF manufacturer's specifications or

4.1.5(a2) Be 1 sq. ft. per 750 CFM of WHF rated airflow

- Exception: Does not apply to WHFs that vent directly to outside.

4.1.5(b) See Section 40 Attic Ventilation.

4.1.5(c) All vents shall be unobstructed and properly blocked from loose fill insulation.

4.1.6 Access, Location, and Fit

4.1.6(a) The WHF inlet shall be located:

4.1.6(a1) At least 3' horizontally away from carbon monoxide and smoke alarms

4.1.6(a2) Centrally in the home, when feasible

4.1.6(a3) In a ceiling area free of obstructions (e.g., pipes, wires, ducts)

4.1.6(a4) Where access to an acceptable electrical circuit is feasible

4.1.6(b) The WHF inlet shall not be located:

4.1.6(b1) In a bedroom, kitchen, or utility room

4.1.6(b2) Anywhere its air movement can adversely affect operation of an open combustion appliance (cause spillage or blow out a standing pilot)

- Note: A WHF may be installed in an attic that contains a closed combustion furnace or an open combustion furnace with electronic ignition.

4.1.7 Electrical Requirements

4.1.7(a) The circuit shall:

4.1.7(a1) Provide constant power to the fan controls (it must not be a switch leg)

4.1.7(a2) Be grounded with adequate overcurrent protection

4.2. Installation Procedure

4.2.1 Fan Mounting

4.2.1(a) Framing/blocks shall be installed between joists, when required, to provide proper mounting and stabilizing surfaces for the WHF.

4.2.1(b) The air path between the attic floor and fan housing shall be enclosed to form a plenum and sealed to prevent infiltration of attic air.

4.2.2 Fan Controls

4.2.2(a) Fan controls shall consist of an on/off feature and a timer.

4.2.2(b) The timer and on/off switch (when present) shall be installed in an electrical box at least 60" above the floor (i.e., higher than nearby light switches).

4.2.2(b1) Exception: Controls may be mounted as low as 48" above the floor when the occupant uses a wheelchair.

4.2.2(c) When the WHF has a pull-chain control (but no remote control), a wall-mounted controller must be installed.

4.2.2(d) Wiring shall be enclosed within a wall cavity whenever possible. When not possible, a raceway must be installed.

4.2.3 Safety Disconnects

4.2.3(a) A thermostatic safety switch to disconnect power to the fan in case of fire shall be installed above the fan in the air path (e.g., on a roof rafter) (Fig. 9-1).

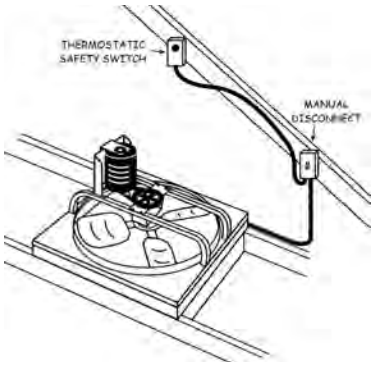


Fig. 9-1: Safety Disconnections

4.2.3(b) A manual disconnect shall be installed in the attic near the fan (Fig. 9-1).

4.2.3(c) An on-off switch shall be wired into the fan circuit within sight of the motor so the unit can be disabled during maintenance.

4.2.4 Insulation and Weatherstripping

4.2.4(a) A fan insulation box will be constructed at a depth to protect the fan housing and motor from insulation (Fig. 9-2).

4.2.4(b) The sides of the fan insulation box assembly will be insulated to the same R-value as the adjoining insulated assembly.

4.2.4(c) Non-compressible insulation will be permanently attached in contact with the fan insulation box.

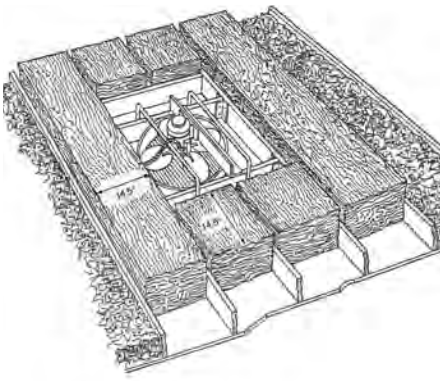


Fig. 9-2: Whole House Fan Insulation Box (Blocking)

4.2.4(d) The fan insulation box frame will be continuously weatherstripped to ensure a tight fit.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 This measure does not apply to mobile homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes except as specified below.

6.1.1(a) A WHF may not be installed in multi-family dwellings thatshare a common attic space.

6.1.2 There are no multi-family whole-building installation requirements. The conventional home criteria apply to all multi-family whole-building installations.

6.1.3 When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.3(a) Common area installation (e.g., in a lobby, entertainment room, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Installation shall be examined for:

8.1.1(a) Proper, secure attachment of the fan to the ceiling joists

8.1.1(b) Correct blocking of loose fill (when applicable)

8.1.1(c) Safe electrical wiring

8.1.2 The unit, including the power switch, speed control, and timer, shall be tested for proper operation.

8.1.3 When present, the hinged insulated lid, backdraft damper, shutter louvers, and separate winter cover shall operate without binding or misalignment.

8.1.4 Operation of the WHF at high speed shall not cause any combustion appliance to fail CAS testing.

8.2. Client Education

8.2.1 The client will be provided with a one-page “How to operate your whole house fan” informational sheet and instructions about required periodic maintenance.

8.2.2 Demonstrate the fan operation and controls to the occupant.

8.2.3 Explain the need to open the required number of windows or doors before turning on the fan.

8.3. Clean-Up and Disposal Requirements

8.3.1 All debris, packaging, and other materials shall be removed from the property and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 20 years

9.1.2 DOE: Not applicable to this measure

9.2 WHF

9.2.1 All WHFs shall:

9.2.1(a) Be Underwriters Laboratories (UL)-listed (or equivalent) and compliant with UL 507

9.2.1(b) Have a thermally protected motor rated for 120-volt alternating current

9.2.1(c) Have a minimum of two speeds or a variable speed control

9.2.1(d) Have a minimum expected service life of 20 years

9.3 Fan Controls

9.3.1 WHF shall have:

9.3.1(a) A wall-mounted or remote-controlled manual-on/automatic-off timer or controller that allows timed operation

9.3.1(a1) The WHF control must not be activated by a device that turns it on automatically.

9.3.1(b) An attic-mounted thermostatic safety limit switch that turns off the WHF when the attic temperature is above 185°F

9.4 Fan Sizing

9.4.1 The appropriate fan CFM shall be determined based on the living space volume or the desired effect using 1.5 CFM/sq. ft. of conditioned floor area.

9.5 Fan System Design

9.5.1 Inline fan: A remote fan connected with a flexible duct to a damper-equipped, ceiling-mount intake assembly/plenum and grille.

9.5.1(a) The duct shall be UL 181 metallic flexible duct or the duct supplied with the fan.

9.5.1(b) The plenum and duct shall be sized in accordance with Building in California’s “Field Duct Sizing Chart” (available at http://buildingincalifornia.com/wp-content/uploads/2014/03/duct-sizing-chart.pdf).

9.5.2 Standard fan: A recessed, ceiling-mounted fan with a barometric shutter.

10. WARRANTY

10.1 Manufacturer warranty—3 years minimum

10.2 Contractor warranty—1 year

10. Air Filters

Table of Contents

Air Filters

1. MEASURE OBJECTIVES

Clean and adequately supported air filters are necessary for the proper functioning of heating, ventilation, and air conditioning (HVAC) units.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Supports can be added to the existing filter to resolve inadequate performance

2.2. Install

2.2.1 The HVAC appliance or window/wall air conditioner (AC) is operable and

2.2.2 The filter is missing or

2.2.3 The existing filter is impacted by dirt and debris or

2.2.4 The existing filter does not meet the material specifications in this measure and the HVAC manufacturer's recommendations

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1. Do Not Repair

3.1.1 Filter support is adequate or cannot be provided when required

3.2. Do Not Install

3.2.1 The existing filter is serviceable, clean, and functions properly

3.2.2 The HVAC appliance or window/wall AC is inoperable and cannot be repaired

3.2.3 Filter replacement would require removal of a flue, duct, or pipe

3.2.4 The filter that complies with the program is specifically prohibited by the HVAC manufacturer

3.2.5 The filter is not available in the proper size or cannot be cut to size

3.2.6 Installation would violate the Appendix E Health and Safety Requirements

3.2.7 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Filter Type

4.1.1(a) Air filter selection shall comply with the HVAC unit manufacturer's specifications.

4.1.1(b) When a minimum efficiency reporting value (MERV) 6 filter is not specifically allowed by the manufacturer's specifications for the existing forced air appliance, a washable "hog hair," foam, or other specialty-type filter shall be installed (to prevent excessive static pressure and appliance failure.)

4.1.2 Filter Sizing

4.1.2(a) All filter types shall be sized, supported, and installed in accordance with appliance manufacturer and filter manufacturer specifications.

4.1.2(b) Unframed filters shall be cut for a snug fit with maximum ¼" tolerance.

4.1.2(c) Framed filters shall fit within the filter housing without crimping or buckling.

4.1.3 Filter Support

4.1.3(a) Materials thinner than 1" shall be secured externally.

4.1.3(b) All unframed filters shall be supported as needed to prevent being drawn toward the air handler, in accordance with manufacturer's instructions.

4.1.3(c) 1" bonded fiber filters

4.1.3(c1) When not in conflict with the appliance manufacturer's or filter manufacturer's instructions, steel rods shall be installed internally as needed to stiffen filters that are 20" or longer in either direction.

4.1.3(c2) Support rods shall be:

- Spaced a maximum of 20" on center
- Sized to fully extend from one edge of the filter to the other
- Inserted in the center of the filter medium, or per manufacturer's instructions

4.1.3(c3) At least one rod shall be positioned so that both ends are supported by a solid surface.

4.1.3(d) A-shaped and V-shaped 1" bonded fiber filters

4.1.3(d1) The HVAC unit shall have:

- Filter access that does not require the removal of any duct or vent pipe
- Both upper and lower support devices (A-shaped filters)
- A bottom support for the filter (V-shaped filters)

4.1.3(d2) Unframed filters:

- One-piece unframed bonded fiber filters shall be cut and installed per the manufacturer's instructions.
- When a single large piece cannot be installed, two pieces of material shall be used.

4.1.3(d3) Framed filters:

- Two framed filters of the correct size shall be installed.
- Large filters shall not be modified to fit by cutting or folding.

4.1.3(e) Horizontal and hammock-style 1" bonded fiber filters

4.1.3(e1) Horizontal unframed filters: Internal support shall be installed as needed.

4.1.3(e2) Horizontal framed filters: Internal support is not required.

4.1.3(e3) Hammock-style filters:

- Unframed filters shall be used.
- The filter shall be secured with the wire mesh hammock.

4.1.3(f) Vertical 1" bonded fiber filters

4.1.3(f1) Unframed filters: Internal support shall be installed as needed.

4.1.3(f2) Framed filters: Internal support is not required.

4.1.3(f3) See Fig. 10-1.

4.1.3(f4) Vertical filter cover:

- When the filter access opening is not sealed by a cover, one shall be provided that blocks leakage.
- Fabricated covers shall be:
  - Made from minimum 26-gauge non-corrosive metal (e.g., galvanized sheet metal)
  - Mechanically secured with metal turn clips or other means that allows easy removal

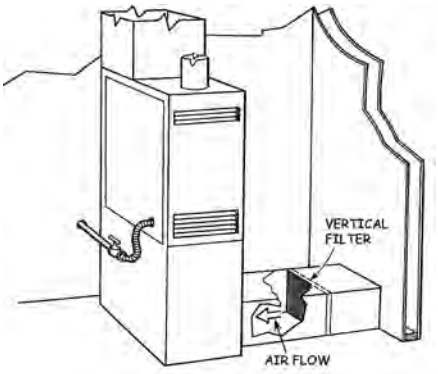


Fig. 10-1: A Vertical Filter In Place

4.1.3(g) Return intake grille applications

4.1.3(g1) All 1" bonded fiber filters

- Unframed filters: Internal support shall be installed as needed.

- Framed filters: Internal support is not required.

4.1.4 Two Filters

4.1.4(a) One return

4.1.4(a1) Eliminate the less accessible filter (if air is filtered twice).

4.1.4(b) Two returns

4.1.4(b1) Each return shall be treated separately as one return.

4.1.4(b2) See Fig. 10-2.

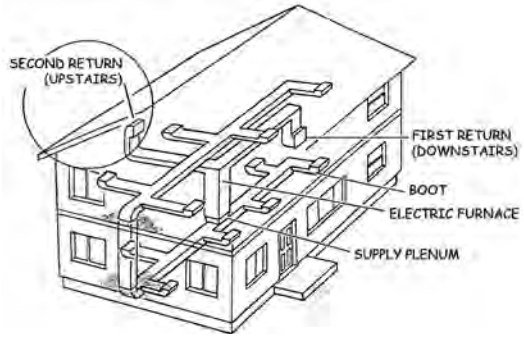


FIG. 10-2: AN EXAMPLE OF A HOME WITH TWO RETURNS

4.1.5 Wall Furnaces

4.1.5(a) Filters shall not be installed on wall furnaces, including models with circulating fans.

4.1.6 Wall-/Window-Mount AC

4.1.6(a) All replacement filters shall comply with the manufacturer's specifications.

4.1.6(b) A ½" bonded fiber unframed filter shall be used when not prohibited by the appliance manufacturer.

4.1.6(c) A foam unframed filter shall be installed only when a ½" bonded fiber filter will not fit properly or is prohibited by the appliance manufacturer.

4.1.6(d) See Fig. 10-3.

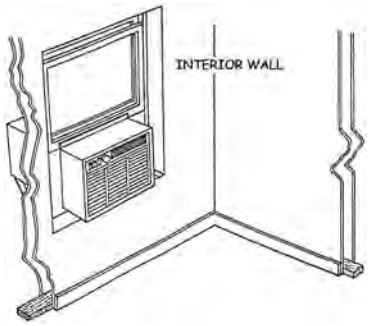


FIG. 10-3: WALL- AND WINDOW-MOUNT AC MAY USE FOAM OR ½" BONDED FIBER FILTERS

4.2. Installation Procedure

4.2.1 Repair

4.2.1(a) If the existing filter does not qualify for replacement but requires supports, install supports per the manufacturer's instructions.

4.2.2 Install

4.2.2(a) Replace the filter per the manufacturer's instructions.

4.2.2(b) Install supports per the manufacturer's instructions when the criteria in Filter Support are met.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

5.1.2 All HVAC Units

5.1.2(a) A reusable filter shall not be installed.

5.1.2(b) Some mobile home manufacturers do not allow the installation of an air filter (e.g., Coleman 8600 "Solar Pack," International, Intertherm, etc.). A filter shall only be installed when the HVAC manufacturer's specifications allow it.

5.1.2(c) 1" bonded fiber filters

5.1.2(c1) A filter shall be installed only on:

- Gas or oil upflow furnaces equipped with AC
- Electric furnaces and heat pumps

5.1.2(c2) The return shall accommodate a 1" filter that can be properly secured with standard retainers.

5.1.2(d) ½" bonded fiber and foam

5.1.2(d1) This filter type (Fig. 10-4) is recommended for downflow units when:

- The return can accommodate the material
- It can be properly secured with standard retainers

5.1.2(d2) Foam shall be installed when:

- The return will not accommodate ½" bonded fiber or
- Bonded fiber is prohibited by the manufacturer

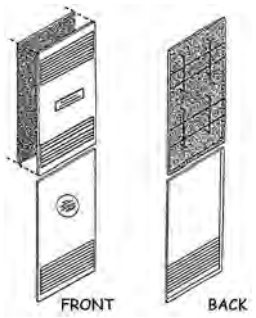


FIG. 10-4: ½" BONDED FIBER OR FOAM FILTER

5.1.3 Ducted Return Intakes

5.1.3(a) See Fig. 10-5.

5.1.3(b) Unframed filters: Internal support shall be installed as needed.

5.1.3(c) Framed filters: Internal support is not required.

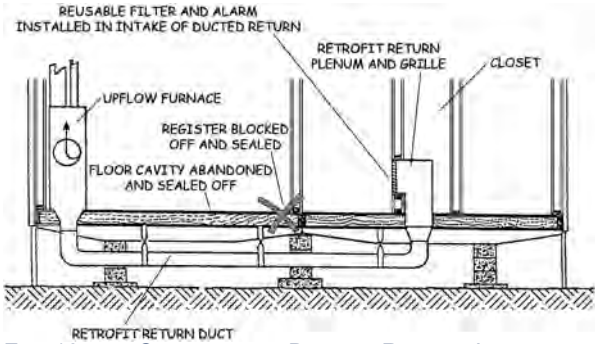


FIG. 10-5: SYSTEM WITH DUCTED RETURN INTAKE

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 Independent FAU

6.1.1(a) When an individual dwelling unit has an independently-operating FAU in a multi-family building, installation requirements for this measure are the same as those for conventional homes.

6.1.2 Common System (Serving Multiple Dwelling Units)

6.1.2(a) The installation of this measure is allowed when the air filter is accessible from the dwelling unit.

6.1.2(b) When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.2(c) When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.2(c1) Common area installation for this measure is not allowed.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is a DOE Audit path, General Heat Waste (GHW) measure. The measures in this category include air filters, faucet aerators, low-flow showerheads, thermostatic showerheads, water heater blankets, and water heater pipe insulation.

7.1.2 When installing this measure as part of the Audit path work scope, a Measure SIR and Dwelling SIR are not required.

7.1.3 The maximum installed cost for all Audit path, GHW measures is $250.

7.1.3(a) When this measure is paid for by LIHEAP, or is cost-shared with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/Priority List Protocol.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Ensure that filters, supports, and covers are installed properly.

8.2. Client Education

8.2.1 Occupants shall be shown how to remove and reinstall the filter.

8.2.2 The importance of timely replacement of the filters for occupant health and appliance operation shall be emphasized.

8.3. Clean-Up and Disposal Requirements

8.3.1 Old filters and debris shall be removed from the premises and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 4 years

9.1.2 DOE: Not applicable to this measure.

9.2 Filters for Existing Forced Air Systems

9.2.1 A MERV 6–type filter shall be used when specifically allowed by the manufacturer of the existing system.

9.2.2 “Hog Hair” Type and Other Bonded Filters

9.2.2(a) 1" thickness shall be used in central HVAC systems.

9.2.2(b) ½" thickness shall be used in a window/wall AC.

9.2.3 Foam Filter

9.2.3(a) The filter shall be ¼" single-layer foam, 20–30 pores per inch.

9.2.3(b) A foam filter shall be installed only when a bonded fiber filter is not feasible or is prohibited by the appliance manufacturer.

9.2.4 Other Materials

9.2.4(a) “Sock”-type foam and other specialty materials shall only be installed when specified by the appliance manufacturer.

9.3 Filters for New Forced Air Systems

9.3.1 Filters shall:

9.3.1(a) Be minimum efficiency reporting value (MERV) 6 or better when installed in a new/replacement forced air unit (FAU) or filter grille

9.3.1(b) Be Underwriters Laboratories (UL)–listed Class 2 filter material

9.3.1(c) Conform to Air-Conditioning, Heating, and Refrigeration Institute (AHRI) 680 or 681 (SI) and UL-900

9.4 Support Rods and Filter Supports for Unframed Air Filters

9.4.1 Support rods shall be corrosion-resistant.

9.4.1(a) Steel rods must be galvanized.

10. WARRANTY

10.1 Manufacturer—90 days

10.2 Contractor—90 days

11. Kitchen Exhaust

Table of Contents

Kitchen Exhaust

1. MEASURE OBJECTIVES

1.1 A functional kitchen exhaust unit with a duct to the outdoors removes airborne grease, combustion by-products, fumes, smoke, heat, and moisture from the living space.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 An existing unit provides local exhaust for the dwelling unit kitchen and

2.1.2 Agency assessment identifies a performance issue (e.g., electrical connections, switch, filter, etc.) and a qualified technician has determined the unit qualifies for repair or

2.1.3 The kitchen exhaust duct is missing, defective, or disconnected and requires repair

2.2. Install

2.2.1 An existing kitchen exhaust unit is inoperable and cannot be repaired

2.2.2 Optional: A recirculating fan is present and is inoperable. The existing unit can be replaced with a ducted kitchen exhaust that vents to the outdoors.

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1. Do Not Repair/Install

3.1.1 Roof access is required and the roof appears unsafe or repair/installation is likely to cause damage or water leaks

3.1.2 A proper electrical circuit is not available and cannot be provided

3.1.3 Repair or installation would violate the Appendix E Health and Safety Requirements

3.1.4 The client refuses after measure benefits have been explained by the assessor

3.2. Do Not Install

3.2.1 No suitable location for proper mounting is available

3.2.2 The existing kitchen exhaust unit is a down-draft or combined microwave/exhaust unit

3.2.2(a) Exception: These exhaust unit types are eligible for replacement by CSD waiver only.

3.2.3 Structural degradation exists that prevents proper installation

3.2.4 Vertical discharge units: Lack of roof access prevents proper installation of a water-tight flashing and roof cap assembly

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Repair or replacement of a vented range hood using an existing duct does not require HERS verification. However, if an entirely new vented range hood is installed, and new or complete replacement duct is also installed, it will require HERS rater verification.

4.1.2 Repair/Install

4.1.2(a) For electrical and grounding requirements and knob-and-tube (K&T) wiring requirements, refer to the manufacturer's instructions and Section 1 General Installation Guidelines, Electrical Guidelines.

4.1.2(b) Passive vent

4.1.2(b1) If a passive vent is present above the cooking appliance as an exhaust unit for the kitchen (typically a metal duct venting outdoors without a fan or damper):

- If local code permits and a program waiver is obtained, a kitchen exhaust fan with a damper may be installed in its place.
- If an exhaust fan will not be installed to a vent terminating in the attic and ceiling insulation will be installed, ¼" mesh shall be added to the vent.

4.1.3 Repair

4.1.3(a) Kitchen exhaust duct extension

4.1.3(a1) Non-conforming kitchen exhaust units shall be ducted to the outdoors with a code-compliant terminal (hood with a backdraft damper and no mesh) when the duct is missing or damaged.

- When venting to the outdoors is not feasible:
  - Ceiling insulation is not feasible
  - The home shall be limited to non-infiltration measures only (the home shall be NIM)
  - Mechanical ventilation (MV) shall be assessed

4.2. Repair Procedure

4.2.1 Ducted Wall and Ceiling Fan Units

4.2.1(a) A defective fan switch, light switch, and/or lamp holder shall be replaced with the manufacturer's replacement part, when possible, or with a compatible retrofit replacement part.

4.2.1(b) All splices shall be secured with new splicing connectors and housed in a junction box.

4.2.1(c) Filter

4.2.1(c1) Damaged, defective, dirty, missing, or non-functioning filters shall be replaced.

4.2.2 Damper Correction

4.2.2(a) The damper shall be cleaned so it operates freely.

4.2.2(b) When feasible, damaged dampers shall be repaired.

4.2.2(c) If the existing damper cannot be made to operate freely, it shall be replaced with the manufacturer's replacement or a compatible damper.

4.2.2(d) If a ducted kitchen exhaust unit is missing a damper, the damper shall be installed as catastrophic leakage under Section 32 Infiltration Reduction.

4.2.2(d1) If damper replacement is not available or feasible, the duct section shall be replaced (including the damper).

4.2.2(d2) Gaps shall be sealed in accordance with Section 32 Infiltration Reduction.

4.2.3 Repairs to Exhaust Duct and Termination

4.2.3(a) All installed ductwork shall conform to Section 8 Ducting, Repair, Sealing, and Insulation.

4.2.3(b) Exhaust ducts shall terminate outdoors in an approved termination device (Fig. 11-1).

4.2.3(c) Existing ducts shall be examined for loose or disconnected joints.

4.2.3(d) Accessible loose joints shall be:

4.2.3(d1) Secured with a clamp or short screws and

4.2.3(d2) Sealed with Underwriters Laboratories (UL)-listed metallic or butyl tape, duct mastic, or mesh tape and mastic

4.2.3(e) When defective ducts cannot be repaired, they shall be replaced.

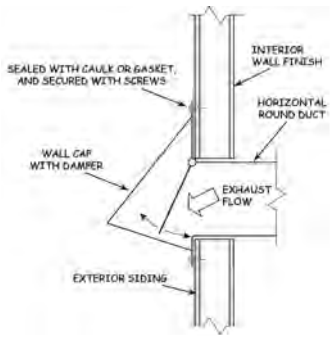


FIG. 11-1: KITCHEN EXHAUST DUCT REPAIR

4.2.3(f) When a kitchen exhaust terminates in an attic or is missing the duct, the duct shall be installed or extended to the outdoors as a part of this measure.

4.2.4 Chain-Operated Wall-Mount Units

4.2.4(a) Broken/defective chains shall be replaced (Fig. 11-2).

4.2.4(b) The interior grille shall be removed, and the fan shall be cleaned (e.g., with a vacuum cleaner and crevice tool).

4.2.4(c) Dirt and grease shall be removed from the fan blade.

4.2.4(d) If the spring-loaded outer cover does not lift when chain is released:

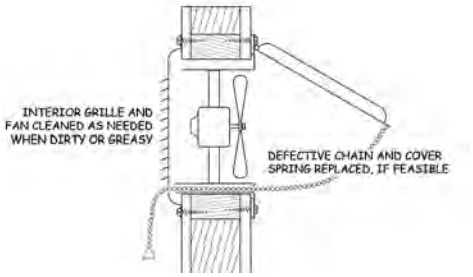


FIG. 11-2: CHAIN-OPERATED KITCHEN EXHAUST

4.2.4(d1) Defective springs shall be repaired/replaced if feasible

4.2.4(d2) The entire fan unit shall be replaced if normal cover function cannot be restored.

4.3. Installation Procedure

4.3.1 Kitchen Exhaust Replacement

4.3.1(a) Verify that the minimum airflow is available before removing the existing unit.

4.3.1(b) The replacement exhaust unit shall be ducted to the outdoors.

4.3.1(c) The finished installation shall have a neat, clean appearance.

4.3.1(d) For wall- and ceiling-mount fans, the interior grille shall completely cover the hole cut for the duct/unit.

4.3.2 Required location and clearances

4.3.2(a) The location shall be assessed to determine whether a new exhaust unit, including electrical wiring and the exhaust duct, can be properly installed before a hole is cut in the ceiling, roof, or wall.

4.3.2(b) If needed, repairs to the mounting location shall be made prior to fan installation.

4.3.2(c) The range hood shall be:

4.3.2(c1) Within 10' of the appliance and

4.3.2(c2) Centered over the cooktop and

4.3.2(c3) At least as wide as the cooktop surface

4.3.2(c4) Located a minimum of 24" above the cooking surface, or as specified by the hood manufacturer

4.3.2(c5) Installed with clearances per manufacturer specifications (e.g., with minimum ¼" clearance between the hood and the underside of combustible material or metal cabinet above)

4.3.3 Electrical Requirements

4.3.3(a) An acceptable power source and electrical circuit that meets the manufacturer's specifications shall be located and verified prior to installation.

4.3.3(b) The power to the fan circuit shall be turned off prior to working with exposed conductors.

4.3.3(c) Wiring

4.3.3(c1) The new fan shall be hard-wired.

- Exception: Plug-in installation is allowed under the following conditions:
  - The existing fan unit plugs into an existing receptacle (e.g., in the cabinet above).
  - The receptacle is properly installed in an electrical box, is safe, and has a proper cover plate.
  - Plug-in installation is approved by fan manufacturer (e.g., unit has a factory-supplied plug-in line cord).

- Excess cord is secured out of the way and protected from damage.

- Extension cords may be used if approved by manufacturer.

4.3.3(c2) The exhaust fan shall be controlled by a switch dedicated to the fan.

4.3.4 Exhaust Duct

4.3.4(a) Duct airflow capacity shall conform to manufacturer's instructions.

4.3.4(a1) Installed ducts shall be sealed in accordance with duct type as in Section 8 Duct Sealing and Repairs, with Duct Supports for supported and Duct Insulation for insulated.

4.3.4(b) Duct location

4.3.4(b1) Ducts shall not interfere with structural members, plumbing, or electrical wiring.

4.3.4(b2) The straightest and most direct route for the duct run shall be used (e.g., through the wall for a range hood located on an outside wall).

4.3.4(b3) Unless otherwise stated in manufacturer's specifications, sidewall exhaust ducts shall terminate at least:

- 3' from openable windows, doors, and other openings into the home (Fig. 11-3)
- 10' from an evaporative cooler or other forced air inlet

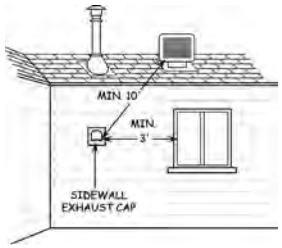


Fig. 11-3: Duct Location Requirements

4.3.4(c) Configuration and joints

4.3.4(c1) The maximum duct length and maximum number of offsets shall be in accordance with manufacturer's instructions.

4.3.4(c2) Joints and connections shall be mechanically secured (e.g., with clamps or short screws) and sealed with elastomeric caulk, or with UL-listed metallic or butyl tape, mastic, or mesh tape and mastic.

4.3.4(d) Vertical ducts

4.3.4(d1) Vertical ducts (Fig. 11-4) shall:

- Extend above the roof a minimum of ¾" and terminate in an approved roof cap with flashing
- Be mechanically secured to roof sheathing or framing with a minimum of two #8 sheet metal screws that penetrate solid wood by at least ⅝"
- Be sealed to the roof surface (e.g., with elastomeric caulk or roofing cement)

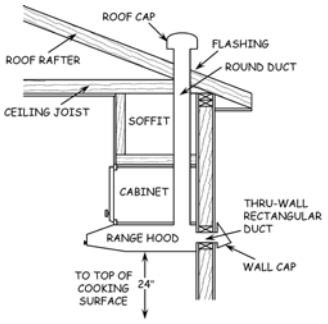


Fig. 11-4: Vertical Duct Requirements

4.3.4(e) Sidewall ducts

4.3.4(e1) Sidewall ducts shall:

- Extend beyond the wall surface approximately ¾" and terminate in an approved wall cap
- Be mechanically secured as needed with #8 sheet metal screws
- Be sealed to the wall surface (e.g., with elastomeric caulk)

4.3.4(f) Termination

4.3.4(f1) The exhaust shall discharge outside the home (to the outdoors, not underneath the dwelling).

4.3.4(f2) The termination shall be flashed and/or caulked around the exterior opening to ensure a weather-tight and waterproof seal.

4.3.4(f3) Terminations shall include a backdraft damper if a damper is not integral to the kitchen exhaust/range hood.

4.3.4(f4) Sidewall terminations shall include a hood to prevent moisture intrusion.

4.3.4(f5) Roof terminations shall include flashing and a roof cap.

4.3.5 Ducted Wall- and Ceiling-Mount Exhaust Fans

4.3.5(a) Size

4.3.5(a1) The replacement fan shall fit the existing location.

4.3.5(b) Ceiling/wall penetration

4.3.5(b1) The hole for the duct shall be large enough to accommodate the duct but smaller than the mounting plate or fan assembly.

4.3.5(b2) The hole for an attic-located fan shall be large enough to install the fan but smaller than the grille/trim.

4.3.5(b3) If the hole must be enlarged, a maximum of 25% of the framing member thickness may be removed.

4.3.5(c) Attachment of exhaust fan

4.3.5(c1) The fan assembly, or mounting plate when used, shall be securely attached to solid wood or metal with minimum #8 screws (Fig. 11-5).

4.3.5(c2) Screws shall penetrate at least ⅝" into the wood.

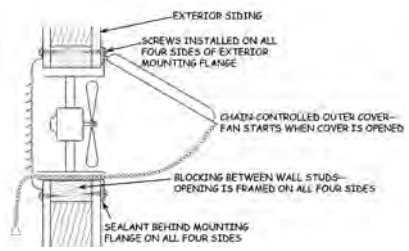


FIG. 11-5: WALL-MOUNT KITCHEN EXHAUST FAN

4.3.5(d) Gaps around the duct shall be sealed where the mounting plate meets the wall (e.g., by applying foam weatherstripping tape to the plate or duct, or by using caulk or tape sealant).

4.3.5(e) Fans located in the attic above the ceiling shall be protected from loose-fill insulation by permanent blocking, in accordance with Section 37 Attic and Ceiling Insulation.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

5.1.2 When a gas cooking appliance is present and a functional kitchen exhaust unit ducted to the outdoors is not present, one shall be installed.

5.1.2(a) If the exhaust fan unit is not feasible to install, the home shall be NIM.

5.1.2(b) The fan inlet shall be installed above, and no more than 10' horizontally from the vertical front of the cooking appliance (range or separate cooktop and oven).

5.1.2(c) Unless otherwise stated in manufacturer's specifications, sidewall exhaust ducts shall terminate at least 3' from:

5.1.2(c1) An openable window, door, and other passive opening into the home

5.1.2(c2) An evaporative cooler inlet or other forced air inlet (e.g., a supply ventilator) into the home

5.1.3 Installation of a Wall-Mount Exhaust Fan

5.1.3(a) Framing

5.1.3(a1) The opening shall be framed on all four sides by lumber equal to or larger than the full-dimensional framing in the wall.

5.1.3(a2) The exterior hole shall be cut large enough to install the fan assembly, leaving adequate exterior wall surface to create a watertight seal.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 Installation requirements for individual multi-family units are the same as those for conventional homes.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.3(a) Common area installation (e.g., in a shared kitchen, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is a DOE Health & Safety (H&S) measure.

7.1.1(a) H&S measures must be installed when feasible. If the client refuses the measure, or it cannot be physically installed due to a dwelling condition, the dwelling must be deferred.

7.1.1(b) When installing this measure as part of the Audit path work scope, a Measure SIR and Dwelling SIR are not required.

7.1.1(c) When installing this measure as part of the Priority List (PL) path work scope, this measure is considered Mandatory, and the measure must be addressed before other PL measures are possible.

7.1.1(c1) Mandatory PL H&S measures include: carbon monoxide (CO) alarms, CVA venting, kitchen exhaust, lead-safe weatherization, LHR-H&S support, mechanical ventilation, and smoke alarms.

7.1.1(d) When this measure is paid for by LIHEAP, or is cost-shared with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/Priority List Protocol.

7.1.2 When kitchen exhaust venting to the outdoors is not feasible, the dwelling shall be deferred.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single Family

7.2.2(a) Excerpted from 2017 SWS 6.6002.2:

7.2.2(a1) Galvanized steel, stainless steel, or copper will be used for termination fitting for kitchen exhaust.

7.2.2(b) Excerpted from 2017 SWS 6.6005.2:

7.2.2(b1) Recirculating fans will not be used as a ventilating device

7.2.2(b2) Makeup air shall be provided in accordance with ASHRAE 62.2 (2016) and in compliance with local jurisdiction.

7.2.2(b3) Metal-to-metal connections will be fastened with a minimum of three equally spaced screws.

7.2.2(b4) Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes.

7.2.2(b5) For down-draft exhaust systems, PVC-to-PVC materials will be fastened with approved PVC cement.

7.2.2(b6) In addition to mechanical fasteners, duct connections will be sealed with UL 181B- or 181B-M-listed material

7.2.3 Mobile Home

7.2.3(a) Excerpted from 2017 SWS 6.6005.2:

7.2.3(a1) Makeup air will be provided for kitchen range fans exhausting more than 200 CFM.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Combustion appliance safety (CAS) testing

8.1.1(a) If CAS or combustion appliance zone (CAZ) testing is required, a post-test shall be conducted after kitchen exhaust installation, repair, or replacement is performed. Follow the procedure outlined in Appendix A Combustion Appliance Safety Protocol.

8.1.1(b) Test all natural draft appliances as prescribed in Appendix A Combustion Appliance Safety Protocol in all locations that can be depressurized by the operating kitchen exhaust unit.

8.2. Client Education

8.2.1 The client shall be supplied with both verbal and written instructions for:

8.2.1(a) Proper operations and maintenance of the kitchen exhaust

8.2.1(b) Safety considerations

8.2.1(c) Warranty

8.2.2 The occupant/property manager shall be advised to keep the grease filters and termination fittings clean.

8.3. Clean-Up and Disposal Requirements

8.3.1 Replaced exhaust fans, parts, and debris shall be removed from the property and disposed of in accordance with local requirements.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 10 years

9.1.2 DOE: Not applicable to this measure

9.2 Duct Materials and Insulation

9.2.1 All ducts shall comply with manufacturer's instructions and local code (e.g., for flame spread rating).

9.2.2 Rigid duct:

9.2.2(a) Galvanized steel: Minimum 26-gauge

9.2.2(b) Aluminum: Minimum 24-gauge

9.2.2(c) PVC smooth plastic pipe: Minimum Schedule 80

9.2.3 Flexible duct:

9.2.3(a) Semi-rigid metallic aluminum: Minimum 0.0065" thick and UL-listed 181B

9.2.4 Duct materials and insulation shall have a maximum flame-spread index of 25 and smoke-developed index of 50 per American Society of Testing and Materials (ASTM) E84, UL 723, or National Fire Protection Association (NFPA) 255

9.2.5 The minimum R-value for duct insulation shall be in accordance with Title 24, by California Energy Commission (CEC) climate zone:

9.2.5(a) Climate zones 3, 5, 6, 7: Minimum R-value of R-6

9.2.5(b) Climate zones 1, 2, 4, 8 – 16: Minimum R-value of R-8

9.3 Motor Repair and Other Component Repairs

9.3.1 The motor shall be UL-listed or a UL-recognized component.

9.3.2 The motor and components shall be replaced with a manufacturer's replacement motor or, if necessary, a compatible model that fits without altering the motor or fan housing.

9.3.3 All exhaust fans/hoods shall be:

9.3.3(a) Listed and labeled for kitchen ventilation by a recognized laboratory, such as UL, European Testing Laboratory, or Canadian Standards Association

9.3.3(b) 100 CFM minimum, or as required per sizing calculations

9.3.3(c) Rated with a noise level of ≤3.0 sones at one or more airflow settings ≥100 CFM, in accordance with American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) 62.2

9.3.3(c1) Exception: Fans with a minimum airflow setting >400 CFM need not comply with the sone requirement.

9.4 Range Hood

9.4.1 Range hood/kitchen exhaust shall:

9.4.1(a) Be as wide as the cooktop and constructed of metal at least 0.0122" thick

9.4.1(b) Have a light and a multi- or variable-speed fan

9.4.1(c) Be equipped with a removable interior grille for wall- and ceiling-mount fans

9.4.1(d) Have exhaust ducts of metal with a smooth interior surface

9.4.1(e) Include a roof flashing system and roof cap for vertical ducts that provide a watertight seal

9.4.1(f) Have durable and waterproof exterior wall components and siding attachments

9.5 Exhaust Terminal

9.5.1 The terminal shall be constructed of aluminum, sheet metal, or ultraviolet (UV)-protected plastic and equipped with maximum ½" weave rodent or insect screen.

9.6 Backdraft Damper

9.6.1 A metal gravity-type backdraft damper shall be located in the fan housing, in the vent duct, or in the wall or roof termination assembly.

9.7 Mobile Home Sidewall Exhaust Fans

9.7.1 The unit shall be designed to fit the wall thickness at the mounting location.

9.8 Kitchen Exhaust Serving as Mechanical Ventilation

9.8.1 When the kitchen exhaust model will be used for dwelling mechanical ventilation, the unit must conform with the sone, fan size limits, and other mechanical requirements in Section 12 Mechanical Ventilation.

9.8.1(a) The maximum fan size for an MV system installed in the kitchen exhaust location is 90 CFM.

9.8.1(b) Intermittent MV units in a kitchen exhaust location shall be certified by the manufacturer to comply with Title 24.

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

12. Mechanical Ventilation

Table of Contents

Mechanical Ventilation

1. MEASURE OBJECTIVES

1.1 Mechanical ventilation (MV) actively introduces fresh air to maintain indoor air quality (IAQ).

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 Assessment of an existing or non-existing MV system (using the CSD 540C Whole-Dwelling Ventilation Calculation Worksheet.) determines mechanical ventilation of ≥16 cu. ft. per minute (CFM) is required

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 An existing MV system is functioning properly and provides the required CFM

3.2 Installation of the MV fan, ducting, or proper termination is unfeasible due to structural issues that cannot be corrected

3.3 A combustion appliance safety (CAS) hazard or CAS fail exists and cannot be corrected per Appendix A Combustion Appliance Safety Protocol

3.4 A required electrical circuit does not exist and cannot be provided

3.5 Installation would violate the Appendix E Health and Safety Requirements

3.6 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Assessments

4.1.1 (a) For dwellings where shell leakage testing is conducted and the blower door test results are utilized to determine if MV must be assessed under the Low Income Home Energy Assistance Program (LIHEAP), refer to CSD Form 704 Shell Leakage Data Sheet.

4.1.1 (b) When blower door testing will be used to calculate the infiltration credit, refer to Appendix C Shell Leakage Testing Protocol.

4.1.1 (b1) Dwellings in which shell leakage testing is not conducted may still be assessed for MV.

4.1.1 (c) Where the installation of MV is required by program guidelines:

4.1.1 (c1) The assessor shall discuss with client that if it is determined that MV is required, but refused, or not feasible to install, the dwelling will be limited to non-infiltration measures only (dwelling will be NIM)

4.1.1 (c2) Air sealing activities shall be performed per Section 32 Infiltration Reduction prior to installation of MV

4.1.1 (c3) If an existing MV is present but is either non-operable or does not meet the MV requirements in the CSD Technical Reference Manual (TRM), the MV will be replaced

4.1.1(d) When a bathroom or dryer vent exhausts into the crawlspace or attic, extension of the venting is required under Section 1 General Installation Guidelines, Limited Home Repair or kitchen exhaust vent under Section 11 Kitchen Exhaust.

4.1.1(d1) If exhaust fan vent extension is not feasible, the exhaust fan may be removed completely and the hole patched only when:

- Allowed by the local jurisdiction (with proof in the client file), AND
- MV is feasible and will be installed.
- Note: If MV cannot be installed, the dwelling is NIM.

4.1.2 Accessibility and Clearances

4.1.2(a) The attic or crawlspace shall be accessible, when required, in accordance with the clearance requirements identified in Section 1 General Installation Guidelines, Attic and Crawlspace Accessibility.

4.1.3 Knob-and-Tube (K&T) Wiring

4.1.3(a) Field personnel, including weatherization crews, must follow Section 1 General Installation Guidelines, Knob-and-Tube (K&T) Wiring Guidelines when K&T is present in the attic, crawlspace, or walls.

4.1.4 Vermiculite Insulation

4.1.4(a) When vermiculite (presumed asbestos-containing material [PACM]) is present:

4.1.4(a1) MV shall be evaluated and, when feasible, installed in accordance with the Appendix E Health and Safety Requirements

4.1.4(a2) It is acceptable to install a supply or balanced ventilator if no asbestos-containing material (ACM) will be disturbed. Exhaust ventilators shall not be installed.

4.2. Installation Procedure

4.2.1 Fan Location

4.2.1(a) The whole house ventilation fan will be installed in a central location within the main body of the house.

4.2.2 Hardware

4.2.2(a) When the fan housing is attached to solid wood, use #8 screws and penetrate solid wood at least ⅝".

4.2.2(b) When the fan housing is not attached to solid wood, use compatible and appropriate fasteners (drywall anchors, molly bolts, toggle bolts, etc.).

4.2.3 Fan Orientation

4.2.3(a) Orient the fan so that it is serviceable and duct runs are as short as possible.

4.2.4 Fan Type

4.2.4(a) Based on client preference, an MV fan may employ continuous or intermittent operation.

4.2.4(a1) The fan type shall be selected after continuous and intermittent operation have been explained to the occupant.

4.2.4(b) Continuous Operation

4.2.4(b1) The “final whole-house ventilation airflow requirement” is the minimum continuous fan airflow required for the whole-house MV system and should be no less than the final ventilation air requirement identified in the CSD 540C Whole-Dwelling Ventilation Calculation Worksheet.

4.2.4(c) Intermittent Operation

4.2.4(c1) Intermittent ventilation requires a greater fan airflow than continuous ventilation. The higher the fan airflow, the shorter the runtime.

4.2.4 (c2)

Intermittent operation is specified as:

- The number of minutes of fan operation during every hour of the day or
- The number of hours of fan operation during the day
  - Minutes-per-hour
    - Intermittent minutes-per-hour fan airflow shall be determined using Table 12-1.
    - The fan shall operate once every hour for the minutes-per-hour runtime (in minutes) from Table 12-1.
  - Hours-per-day
    - Intermittent hours-per-day fan airflow shall be determined using Table 12-2.
    - The fan shall cycle on at least 1 hour in every 3 hours and operate a minimum of 8 hours per day.

TABLE 12-1: MINUTES-PER-HOUR RUNTIME

Continuous Fan CFM	Intermittent Fan CFM and Minutes-per-Hour Runtime													
	30	40	50	60	70	80	90	100	110	120	130	140	150	160
30	60	45	36	30	26	23	20	18	16	15	14	13	12	11
35	NA	53	42	35	30	26	23	21	19	18	16	15	14	13
40	NA	60	48	40	34	30	27	24	22	20	18	17	16	15
45	NA	NA	54	45	39	34	30	27	25	23	21	19	18	17
50	NA	NA	60	50	43	38	33	30	27	25	23	21	20	19
55	NA	NA	NA	55	47	41	37	33	30	28	25	24	22	21
60	NA	NA	NA	60	51	45	40	36	33	30	28	26	24	23
65	NA	NA	NA	NA	56	49	43	39	35	33	30	28	26	24
70	NA	NA	NA	NA	60	53	47	42	38	35	32	30	28	26
75	NA	NA	NA	NA	NA	56	50	45	41	38	35	32	30	28
80	NA	NA	NA	NA	NA	60	53	48	44	40	37	34	32	30
85	NA	NA	NA	NA	NA	NA	57	51	46	43	39	36	34	32
90	NA	NA	NA	NA	NA	NA	60	54	49	45	41	39	36	34
95	NA	NA	NA	NA	NA	NA	NA	57	52	48	44	41	38	36
100	NA	NA	NA	NA	NA	NA	NA	60	55	50	46	43	40	38

*The fan must operate once every hour for the number of minutes shown in the body of the table. NA = Not allowed.

TABLE 12-2: HOUR-PER-DAY RUNTIME

Continuous Fan CFM	Intermittent Fan CFM and Hours-per-Day Runtime*												
	40	50	60	70	80	90	100	110	120	130	140	150	160
30	18	14	12	10	9	8	8	8	8	8	8	8	8
35	21	17	14	12	11	9	8	8	8	8	8	8	8
40	24	19	16	14	12	11	10	9	8	8	8	8	8
45	NA	22	18	15	14	12	11	10	9	8	8	8	8
50	NA	24	20	17	15	13	12	11	10	9	9	8	8
55	NA	NA	22	19	17	15	13	12	11	10	9	9	8
60	NA	NA	24	21	18	16	14	13	12	11	10	10	9
65	NA	NA	NA	22	20	17	16	14	13	12	11	10	10
70	NA	NA	NA	24	21	19	17	15	14	13	12	11	11
75	NA	NA	NA	NA	23	20	18	16	15	14	13	12	11
80	NA	NA	NA	NA	24	21	19	17	16	15	14	13	12
85	NA	NA	NA	NA	NA	23	20	19	17	16	15	14	13
90	NA	NA	NA	NA	NA	24	22	20	18	17	15	14	14
95	NA	NA	NA	NA	NA	NA	23	21	19	18	16	15	14
100	NA	NA	NA	NA	NA	NA	24	22	20	18	17	16	15

*The fan must operate at least 1 hour every 3 hours, and the daily total shall equal the number of hours shown in the body of the table (minimum 8 hours per day). NA = Not allowed.

4.2.5 Existing Fans

4.2.5(a) An existing fan may be used as a whole-house ventilator only when it conforms to Material Specifications.

4.2.5(b) The measured CFM of an existing exhaust fan shall be used for the local ventilation adjustment only when the fan is operable and ducted outdoors.

4.2.6 MV Bathroom and Kitchen Exhaust Installation.

4.2.6(a) Refer to Section 11 Kitchen Exhaust for complete kitchen exhaust requirements.

4.2.6(b) Title 24 requires that, when a new fan is installed in a bathroom or kitchen, it must operate at a minimum of:

4.2.6(b1) 50 CFM when the bathroom is occupied

4.2.6(b2) 100 CFM for a kitchen

4.2.6(c) To replace an existing local exhaust in a bathroom or kitchen with MV, use the CSD 540C Whole-Dwelling Ventilation Calculation Worksheet to determine the size of the fan to be installed.

4.2.7 Sealing the Fan

4.2.7(a) Seal exterior gaps between the terminal device and the mounting surface (roof or wall) to be watertight using weather-resistant materials (e.g., elastomeric caulk).

4.2.7(b) Seal interior gaps between the register/grille and the interior surface.

4.2.7(c) Wet the gypsum edge before applying water-based sealant to the gypsum board.

4.2.8 In-Ceiling Fan Installation

4.2.8(a) Flange mount

4.2.8(a1) Mount the fan:

- Directly to the ceiling joists when spacing is appropriate or
- To block framing installed to accommodate the fan's dimensions

4.2.8(b) Bracket mount

4.2.8(b1) Mount the fan to the ceiling joists using the supplied mounting brackets, rough-in adapter, etc.

4.2.8(b2) Use spacers when required to ensure that the fan assembly is mounted parallel to the joist.

4.2.9 In-Line Fan Installation

4.2.9(a) Isolate the fan from the building framing unless it is designed to be directly attached.

4.2.9(b) Mount the fan with appropriate mounting brackets or spring-equipped hangers.

4.2.9(c) Install the duct to connect with the supply/exhaust register or grille.

4.2.10 In-Wall Fan Installation

4.2.10(a) Flange mount

4.2.10(a1) Mount the fan:

- Directly to wall studs when spacing is appropriate or
- To block framing installed to accommodate the fan's dimensions

4.2.10(b) Bracket mount

4.2.10(b1) Mount the fan to the wall studs using the supplied mounting brackets, a rough-in adapter, etc.

4.2.10(b2) Use spacers when required to ensure that the fan assembly is mounted parallel to the stud.

4.2.11 Duct Installation

4.2.11(a) Install ducts as straight as possible, fully extended, with the shortest possible run.

4.2.11(b) Mechanically secure, seal, and support all joints, seams, transitions, and terminations.

4.2.11(c) In addition to mechanical fasteners, duct connections will be sealed with approved tape or mastic.

4.2.12 Backdraft Damper Installation

4.2.12(a) If not integral to the fan, install a backdraft damper to open in the desired flow direction.

4.2.12(b) For exhaust systems, install a gravity-controlled damper at the exterior wall or roof cap assembly so it blows open when the fan is operating and falls closed when the fan is off.

4.2.12(c) For supply systems, install a spring-loaded butterfly damper that fits into the duct on the inlet side of the fan so it pulls open when the fan is operating and falls closed when the fan is off.

4.2.13 Controller Installation and Programming

4.2.13(a) Install the fan controller if it is not built into the fan.

4.2.13(b) Program the controller to achieve the required CFM of airflow for continuous or intermittent operation (minutes-per-hour or hours-per-day).

4.2.14 Balanced Ventilators—Heat Recovery Ventilators (HRVs) and Energy Recovery Ventilators (ERVs)

4.2.14(a) Installation location

4.2.14(a1) Units shall not be installed in the kitchen or bathroom.

4.2.14(a2) Fans, service switches, filters, drains, and drain pans shall be accessible for maintenance (Fig. 12-1).

4.2.14(a3) HRV location shall accommodate a condensate drain (if required).

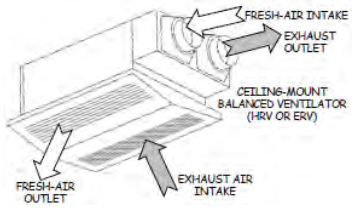


Fig. 12-1: Balanced Ventilator

4.2.14(a4) Attic-mount units are allowed only when the fan can be located next to the attic access opening in a manner that allows easy access for required maintenance.

4.2.14(a5) When there are multiple intakes/outlets, terminals shall be installed in separate areas of the living space.

4.2.14(a6) Separate outlet/inlet terminals shall be a minimum of 3’ apart.

4.2.14(a7) In-ceiling units shall be placed in a central location (e.g., hallway) or living area (e.g., living room).

4.2.14(a8) Wall-mount units shall be located in a living area (e.g., living room).

4.2.14(b) Fan mounting

4.2.14(b1) The fan shall be oriented so the equivalent length of the duct run is as short as possible.

- Calculate “equivalent length” in accordance with Table 12-3.

4.2.14(b2) The fan shall be isolated from the building framing unless specifically designed to be directly attached.

4.2.14(c) Duct connections

4.2.14(c1) Ducts shall be properly connected and secured to applicable registers or grilles, collector boxes, HRVs or ERVs, intake fittings, and termination fittings.

4.2.14(c2) Fittings shall be appropriate for regional weather conditions and the installation location on the house so as not to be rendered inoperable.

4.2.14(c3) A backdraft damper will be installed between the HRV or ERV and the exterior, unless the system operates continuously.

4.2.14(d) Duct layout when connected to a forced air system

4.2.14(d1) Air to be exhausted to the outdoors shall not be taken directly from the forced air system.

4.2.14(d2) Supply ducts attached to the return side of forced air systems shall be:

- Attached as close to the forced air fan as possible using a mechanically fastened start collar.
- Set up to provide filtration of outdoor ventilation air before reaching the heating, ventilation, and air conditioning (HVAC) system with an air filter with a minimum efficiency reporting value (MERV) of 6 or better.

4.2.14(e) Balance and flow

4.2.14(e1) Airflow shall be measured and adjusted to match to the system’s intent.

4.2.15 Ducts

4.2.15(a) Duct diameter (or rectangular cross-sectional area), number of elbows, and maximum length shall be as specified in Table 12-3, or by the fan manufacturer’s specifications if more stringent.

TABLE 12-3: MAXIMUM DUCT LENGTH (FT.) WITH NO ELBOWS[1, 3, 4, 5, 6]

Minimum Duct Diameter[2]	Fan CFM	Flex Metal Duct								Rigid Metal and PVC Duct							
		50	80	100	125	150	200	250	300	50	80	100	125	150	200	250	300
	3"	NA	NA	NA	NA	NA	NA	NA	NA	5'	NA	NA	NA	NA	NA	NA	NA
	4"	56'	4'	NA	NA	NA	NA	NA	NA	114'	31'	10'	NA	NA	NA	NA	NA
	5"	No limit	81'	42'	16'	2'	NA	NA	NA	No limit	152'	91'	51'	28'	4'	NA	NA
	6"	No limit	No limit	158'	91'	55'	18'	1'	NA	No limit	No limit	No limit	168'	112'	53'	25'	9'
	7"	No limit	No limit	No limit	No limit	161'	78'	40'	19'	No limit	No limit	No limit	No limit	No limit	148'	88'	54'
	≥8"	No limit	No limit	No limit	No limit	No limit	189'	111'	69'	No limit	No limit	No limit	No limit	No limit	No limit	198'	133'

[1] The table assumes no elbows. Make the following deductions:
- Subtract 15 ft. for each 90° elbow.
- Subtract 7.5 ft. for each 45° offset.

[2] For non-circular ducts, calculate the diameter as four times the cross-sectional area divided by the perimeter.

[3] For these components, use the manufacturer's specifications. If not available, use these guidelines:
- Subtract 30 ft. for a wall cap with bird screen and damper.
- Subtract 35 ft. for a low-profile soffit vent with bird screen and damper.
- Subtract 60 ft. for a low-profile roof cap for round duct with bird screen and damper.

[4] NA = Not allowed

[5] No limit = At this duct diameter, there is no limit on the maximum duct length.

[6] For airflow values not listed, use the next highest value (e.g., for 60 CFM, use the columns for 80 CFM).

4.2.15(b) Existing ducts

4.2.15(b1) Duct used for whole-house MV shall be:

- Replaced or repaired if damaged
- Repaired and sealed as needed
- Replaced if undersized

4.2.15(c) New ducts

4.2.15(c1) All ducts shall:

- Terminate outside the building in an approved wall or roof cap termination
- Slope downward toward the exterior, when possible, to remove condensation to the outdoors
- Installed ducts shall be sealed in accordance with duct type as in Section 8 Duct Sealing, Repair, and Insulation, supported in accordance with Duct Supports requirements of that section, and insulated following the Duct Insulation requirements.

4.2.15(d) Airflow characteristics:

4.2.15(d1) Rigid metal or polyvinyl chloride (PVC) ducts have the best airflow characteristics (Fig. 12-2).

4.2.15(d2) Flexible metal ducts have the next-best airflow.

4.2.15(e) Insulation

4.2.15(e1) Ducting located outside of the thermal envelope shall be insulated in accordance with Material Specifications.

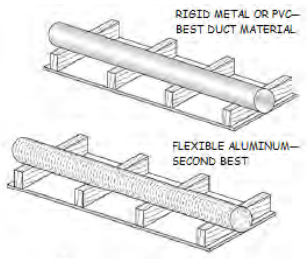


FIG. 12-2: PROPER DUCT MATERIALS FOR BEST AIRFLOW

4.2.15(f) Bends and elbows

4.2.15(f1) Ducts shall be installed with the shortest possible length and fewest possible bends or elbows.

4.2.15(f2) A straight duct shall extend 24"–36" from the fan before the first bend or elbow.

4.2.15(f3) Bends and 45º offsets shall be used instead of 90º elbows, when possible, to create long-radius bends (Fig. 12-3).

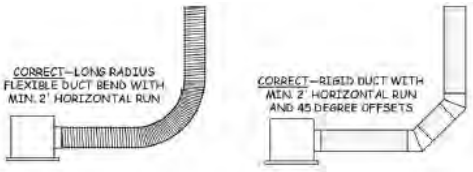


Fig. 12-3: Correct Installation of Bends and Elbows

4.2.15(f4) Turns will be made so the radius at the centerline is no less than one duct diameter.

4.2.15(f5) When determining diameter and length requirements, bends of ≤45º constitute the equivalent of half a 90º elbow (two of them count as one elbow).

- Each bend >45º constitutes the equivalent of one 90º elbow.

4.2.15(f6) Duct elbows shall:

- Be a maximum of 90º
- Be limited to three elbows for duct diameters 4" or larger
- Not be used in 3" diameter duct

4.2.15(g) Transitions

4.2.15(g1) Ventilation ducts shall not be smaller than the connections to which they are attached. When duct (exhaust fan outlet) and collar diameters do not match, a properly sized rigid metal transition (reducer or increaser) shall be used to join the two components.

4.2.15(h) Duct terminations

4.2.15(h1) Horizontal ducts shall terminate outside the building in a wall termination assembly (Fig. 12-4).

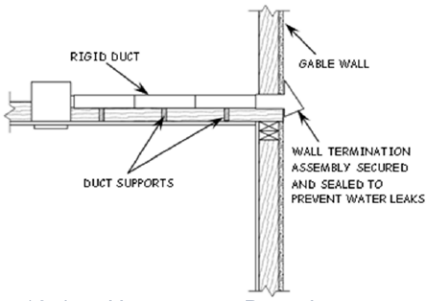


Fig. 12-4: Horizontal Duct Installation and Termination

4.2.15(h2) Vertical ducts shall terminate outside the building in a roof cap assembly (Fig. 12-5).

4.2.15(i) Supports

4.2.15(i1) Support materials shall not crimp the ductwork or cause the interior dimensions of the ductwork to be less than specified.

4.2.15(i2) At a minimum, metal ducts shall be supported by ½" or wider 18-gauge strapping, or 12-gauge or thicker galvanized wire, no more than 10' apart.

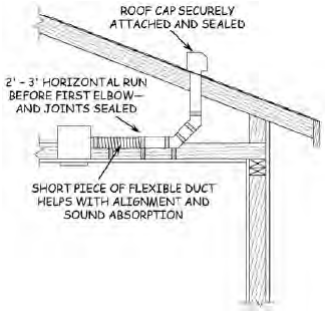


Fig. 12-5: Vertical Duct Installation and Termination

4.2.16 Backdraft Dampers

4.2.16(a) Outdoor air intakes and exhausts shall be equipped with automatic or gravity dampers that close when the ventilation system is not operating.

4.2.16(b) The damper may be integral (part of the fan unit) or included in the termination (wall or roof cap assembly).

4.2.16(c) Multi-branch duct systems

4.2.16(c1) When the fan is intermittent, each branch shall be equipped with a backdraft damper to prevent movement of air from one room to another when the fan is not operating.

4.2.16(d) It is acceptable for the damper to be located in the branch duct or in the inlet/outlet location.

4.2.17 Wall Openings

4.2.17(a) Wall opening shall be:

4.2.17(a1) Adjacent to one stud so that one edge of the housing can be secured to solid wood (Fig. 12-6)

4.2.17(a2) Free of obstructions (wiring, pipes, etc.)

4.2.17(a3) No larger than ¼" greater than the duct diameter or fitting so the fan housing and duct can be properly installed

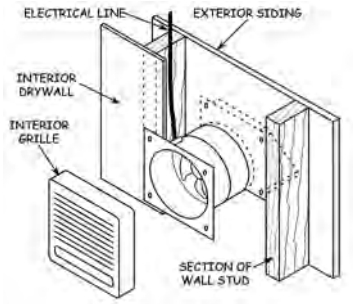


FIG. 12-6: WALL VENT OPENING ADJACENT TO STUD

4.2.18 Roof and Wall Cap Assembly (Termination)

4.2.18(a) Existing whole-house MV systems shall be vented to the outdoors with a code-compliant terminal (a hood with a backdraft damper and covered with a screen).

4.2.18(b) The terminal shall be screened with mesh that has a weave of ¼" minimum and ½" maximum.

4.2.18(c) The termination shall be secured and sealed to prevent water leaks.

4.2.18(d) Installation fasteners and screening shall not inhibit damper operation.

4.2.18(e) The exterior termination fitting will be flashed or weather-sealed to direct water away from penetrations.

4.2.18(f) The termination fitting shall have an integrated collar at least the same diameter as the exhaust fan outlet.

4.2.18(g) If the collar is larger than the exhaust fan outlet, a rigid metal transition (increaser/reducer) shall be used.

4.2.18(h) The termination shall be appropriate for regional weather conditions and located so that it is not obstructed by snow, vegetation, or other material.

4.2.19 Clearances for Roof and Wall Cap Terminations

4.2.19(a) The following roof and wall termination guidelines apply unless superseded by manufacturer or local code.

4.2.19(a1) The inlet for a mechanical system shall be at least:

- 10' from or 3' below a gas vent pipe or a solid-fuel chimney
- 10' from a bathroom or kitchen exhaust, plumbing vent, clothes dryer exhaust, vehicle exhaust source, or other source of toxic contamination
- 3' from an attic vent or gas meter set assembly

4.2.19(a2) The outlet for a mechanical system shall be at least:

- 10' from an evaporative cooler or mechanical air inlet
- 3' from an operable door or window into the building
- 3' from a property line

4.2.20 Air Filters

4.2.20(a) Balanced or supply-type MV ventilators

4.2.20(a1) When required by the manufacturer, the filter shall be located and installed in a manner that facilitates easy access and regular service by the occupant.

4.2.20(a2) For in-line or remote supply fans, a filter grille or similar device shall be installed at the supply outlet.

4.2.20(a3) A filter or air cleaning system that intentionally produces ozone is not allowed.

4.2.20(b) Passive inlet vents

4.2.20(b1) A factory-installed filter shall be present.

4.2.21 Fan Controllers

4.2.21(a) Controller installation guidelines

4.2.21(a1) Bathroom fan controls and switches (Fig. 12-7) shall not be reachable from a tub or shower.

4.2.21(b) Manual override control

4.2.21(b1) Each installation shall have a readily accessible override control for the occupants, which can be any of the following:

- A labeled wall switch (Fig. 12-8)
- A control on the fan unit that can easily be accessed by removal of a cover plate or grille without the use of tools
- A labeled breaker dedicated to operation of the ventilator

4.2.21(b2) Accessible controls shall have a durable label informing occupants that the fan should be turned on whenever the home is occupied, using wording such as:

- "Ventilation Control: Keep On When Home Is Occupied" or
- "Ventilation Control: Keep On When Anyone Is Home"

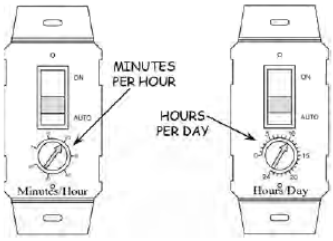


FIG. 12-7: INTERMITTENT PROGRAMMING FAN CONTROLLERS

FIG. 12-8: LABELED SWITCH FOR MECHANICAL VENTILATION OVERRIDE CONTROL

4.2.22 Electrical Wiring

4.2.22(a) Turn off power at its source (breaker or fuse) prior to working with electrical components (fan, controller, etc.).

4.2.22(b) The fan power circuit shall be protected by a ground fault circuit interrupter (GFCI).

4.2.23 Pressure Balancing

4.2.23(a) When shell leakage testing is not performed, complete prescriptive sealing in accordance with the CSD 704 Shell Leakage Data Sheet prior to pressure balance testing.

4.2.23(b) When an MV system is installed, perform pressure balance testing using the following procedure:

4.2.23(b1) Close exterior doors and windows.

4.2.23(b2) Close interior doors.

4.2.23(b3) Turn on the MV system and other exhaust fans and devices.

4.2.23(b4) Using a digital gauge, extend the tubing from the reference tap to the outdoors.

4.2.23(b5) Extend tubing from the input tap under each interior door in the dwelling individually to measure room pressure with reference to the outdoors.

4.2.23(c) If any room exceeds ±3 pascals (Pa) with reference to the outdoors, install an appropriate means of pressure balancing (e.g., passive inlet vents, transfer grilles, door undercuts, jump ducts, individual room returns, etc.).

4.2.24 CAS/Combustion Appliance Zone (CAZ) Testing

4.2.24(a) Mechanical ventilation shall not cause any vented open combustion appliance in the living space to draft improperly or spill.

4.2.24(b) If CAS or CAZ testing is required, it shall be conducted in accordance with the following procedure (Fig. 12-9) after the MV system is installed.

4.2.24(c) Pressure in any CAZ shall not be more negative than the house depressurization limit (HDL) per guidelines in Appendix A Combustion Appliance Safety Protocol.

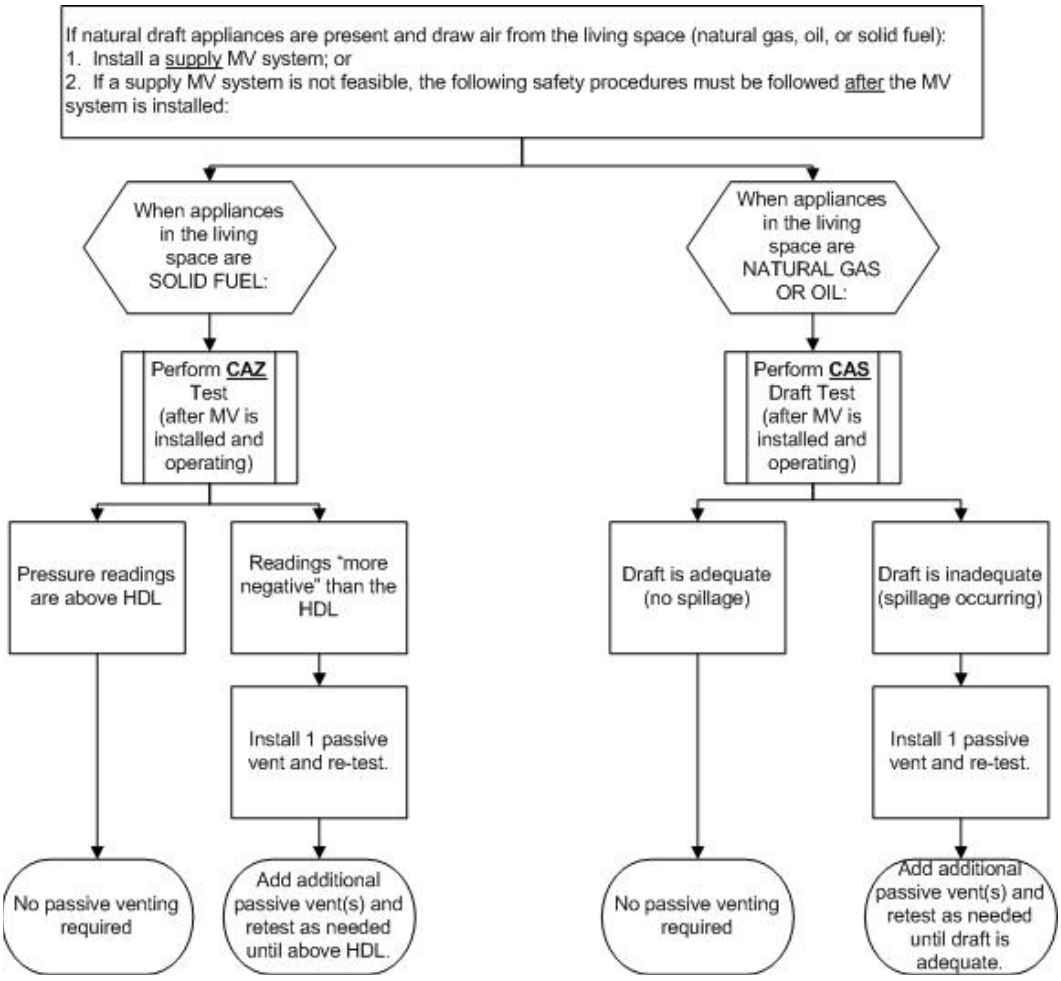


FIG. 12-9: CAS/CAZ PASSIVE VENTILATION PROCEDURE

4.2.25 Passive Inlet Vents (Make-Up Air)

4.2.25(a) A passive vent is used to provide make-up air from the outdoors to minimize or prevent house depressurization (Fig. 12-10).

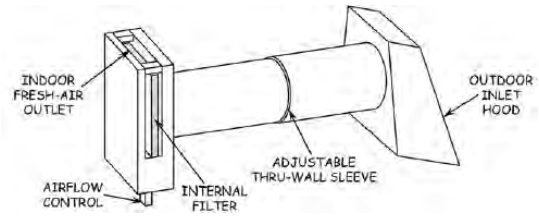


FIG. 12-10: PASSIVE INLET VENT

4.2.25(b) Passive inlet vents are not applicable to meet code requirements for combustion ventilation air (CVA) vents; however, by relieving house depressurization, they help resolve backdrafting problems of natural draft appliances. To use this option, CVA must be calculated using Appendix A Combustion Appliance Safety Protocol.

4.2.25(c) Installation/location

4.2.25(c1) The vent shall be installed on an outside wall in a location that does not produce a draft that would cause occupant discomfort, such as:

- High on a wall and away from seating areas or
- Inside a closet or enclosure that is vented to the living space

4.2.25(c2) The passive inlet vent shall be located and installed:

- With a maximum ¼" insect/rodent screen at the air inlet to prevent pest intrusion and
- With approved clearances from sources of contamination

4.2.25(c3) The outdoor inlet shall be sealed against the wall to prevent water leakage.

4.2.26 Transfer Grilles, Jump Ducts, and Door Undercuts

4.2.26(a) When the MV fan is in a bathroom (or other room with a solid door), an air path into the main body of the home shall be present that provides airflow at least equal to the fan CFM.

4.2.26(a1) A transfer grille or jump duct may be installed, or the door may be undercut.

4.2.26(a2) When a transfer grille is installed:

- Its net free ventilation area (NFVA) shall equal or exceed the NFVA of the required door undercut (see Table 12-4) or
- The net opening square inches of the transfer grille (e.g., louvered metal vent) shall equal or exceed the net opening square inches of the MV fan's intake grille

TABLE 12-4: DOOR UNDERCUT GUIDELINES

Fan Airflow	Up to 80 CFM	>80–100 CFM	>100–120 CFM	>120–140 CFM	>140–180 CFM
Gap Size	⅜"	½"	⅝"	¾"	⅞"
NFVA Sq. In.	[Door opening width (in.)] x [Undercut height (in.)]				

4.2.26(a3) When a jump duct is installed:

- The interior cross-sectional area of the duct shall equal or exceed the NFVA of the required door undercut (see Table 12-4) and
- The NFVA of the jump duct inlet and outlet registers shall equal or exceed the NFVA of the required door undercut

4.2.26(a4) When a door undercut is used to provide the required air path:

- The guidelines in Table 12-4 shall be followed
- The client shall be made aware that, if a thicker floor covering (e.g., carpet) is installed, the gap must be maintained, which may require enlargement of the undercut

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

5.1.2 When a gas or solid-fuel open-combustion appliance draws combustion air from the living space, combustion appliance zone (CAZ) testing shall be performed following MV installation to determine that MV does not cause depressurization beyond the house depressurization limit. See Appendix A Combustion Appliance Safety Protocol.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 Installation requirements for individual multi-family units are the same as those for conventional homes.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.3(a) Common area installation (e.g., in a lobby, entertainment room, hallway, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 The program goals are to seal the dwelling to the maximum amount allowable within the shell sealing policy and to install MV to provide adequate air changes/ventilation when needed.

7.1.2 100% of the dwellings utilizing any amount of DOE funds shall be assessed for MV.

7.1.3 This measure is a DOE Health & Safety (H&S) measure.

7.1.3(a) H&S measures must be installed when feasible. If the client refuses the measure, or it cannot be physically installed due to a dwelling condition, the dwelling must be deferred.

7.1.3(b) When installing this measure as part of the Audit path work scope, a Measure SIR and Dwelling SIR are not required.

7.1.3(c) When installing this measure as part of the Priority List (PL) path work scope, this measure is considered Mandatory, and the measure must be addressed before other PL measures are possible.

7.1.3(c1) Mandatory PL H&S measures include: carbon monoxide (CO) alarms, CVA venting, kitchen exhaust, lead-safe weatherization, LHR-H&S support, mechanical ventilation, and smoke alarms.

7.1.3(d) When this measure is paid for by LIHEAP, or is cost-shared with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/Priority List Protocol.

7.1.4 When venting to the outdoors for local exhaust sources and/or a dryer moisture exhaust is not feasible, and correction is not possible as described in item 4.1.1d, then the dwelling shall be deferred.

7.1.5 If the MV measure is required and is not installed, the dwelling shall be deferred.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2(a) Excerpted from 2017 SWS 6.6002.1:

7.2.2(a1) Ducts

- Flexible and duct board ducts and plenums will be supported every 4' using a minimum of 1½"-wide material
- Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws
- Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes
- Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool
- PVC-to-PVC materials will be fastened with approved PVC cement

7.2.2(b) Excerpted from 2017 SWS 6.6003.3:

7.2.2(b1) Through the Wall Fans

- If system operates continuously, fan housing need not be insulated.

7.2.2(b2) Make-up air will be provided in accordance with the current version of [American Society of Heating, Refrigeration, and Air-Conditioning Engineers] ASHRAE 62.2 and in compliance with the authority having jurisdiction.

7.2.2(c) Excerpted from 2017 SWS 6.6102.1:

7.2.2(c1) Outdoor air ventilation supply ducts attached to the return side of forced air systems will be set up to provide filtration of outdoor ventilation air before reaching the HVAC system (minimum MERV 6 filter).

7.2.2(c2) Outdoor Air Intake

- All connections will have a contact overlap of at least 1"
- Flexible duct between the cable tie and end of metal or PVC duct will be screwed [into place]
- Outdoor air intake will be installed in accordance with the following:
  - A minimum of 6" from grade
  - Above local snow or flood line
  - A minimum of 18" above an asphalt based roof
  - Never on a flat roof

7.2.2(d) Excerpted from 2017 SWS 6.6102.2:

- Intake fitting will be labeled “ventilation air intake”
- Occupant will be instructed to keep yard debris and other contaminants clear of the intake

7.2.2(e) Excerpted from 2017 SWS 6.6202.9:

7.2.2(e1) The filter access panel will include a gasket or comparable sealing mechanism and fit snugly against the exposed edge of the filter when closed to prevent air bypass.

7.2.2(e2) The filter plenum construction will be airtight and sealed to the adjoining ductwork.

7.2.3 Mobile Home

7.2.3(a) Excerpted from 2017 SWS 6.6003.6:

7.2.3(a1) Fan will be secured to a structural component

7.2.3(a2) Structural integrity of the manufactured home will be maintained (e.g., roof trusses, walls, floor joists)

7.2.3(a3) Ventilation system configuration

- Consideration will be given to fan clearance, head clearance, power source location, vent termination location, space required for duct run, roof condition and type, and duct insulation.

7.2.3(b) Excerpted from 2017 SWS 6.6205.1:

7.2.3(b1) Exhaust-Only Ventilation

- ASHRAE 62.2 will be referenced for climate considerations
  - Whole house mechanical net exhaust flow for hot-humid climate will not exceed 7.5 cubic feet per minute/100 square feet

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Installers

8.1.1(a) Final testing of the system shall be performed by field personnel to ensure proper operation and performance of all functions, including acceptable system airflow CFM (in accordance with ASHRAE 62.2).

8.1.1(b) Airflow shall be checked on all installed whole-house MV systems and new/replacement kitchen exhaust systems using an approved device. (See Material Specifications.)

8.1.1(c) Visual inspection

8.1.1(c1) Visual inspection shall be performed and documented.

8.1.1(c2) The termination shall be checked for proper clearances, attachment, support, and water sealing.

8.1.1(d) All non-conforming conditions shall be corrected.

8.1.2 Inspectors

8.1.2(a) Fan airflow verification

8.1.2(a1) Assessors, crews, and inspectors are required to measure airflow for existing fans and for the installed MV fan.

8.1.2(a2) Airflow measurements for whole-house and local ventilators (new and existing) shall be conducted using an appropriate airflow measuring device, as prescribed in Material Specifications.

8.1.2(a3) The measuring device must be appropriate for the airflow (CFM) and air pressure (pascals [Pa]) being measured and for appropriate airflow type (exhaust, supply, or balanced).

8.1.2(b) Verify proper damper operation.

8.2. Client Education

8.2.1 The assessor shall educate the client about:

8.2.1(a) The purpose of an MV system

8.2.1(b) The air quality benefits of the system

8.2.1(c) Proper maintenance, operation and use of controls

8.2.1(d) Manual override

8.2.2 For an HRV or ERV, emphasize regular cleaning of the filter and core to maintain the required airflow.

8.2.3 Mandatory operation guide/label:

Information about Your Whole-House Mechanical Ventilation System and Maintenance Requirements					
Installer	Contractor Best CSD Agency		Phone 916-916-9169	Address 123 Good St., Goodtown 91919	
System Type	❑ Supply Ventilator ❑ Exhaust Ventilator ❑ Exhaust with Passive Inlet ❑ Heat Recovery Ventilator (HRV) ❑ Energy Recovery Ventilator (ERV)				
Purpose	• The purpose of mechanical ventilation is to provide adequate fresh air inside the home. • System size (airflow) is based on the size of your home and the number of occupants. • There is a manual override switch; however, it should be switched on whenever anyone is at home. Too little ventilation can cause moisture and health problems.				
Ventilator Unit (Fan)	Brand Acme FanCo	Model # AV-1234567	Required Airflow (cfm) 40 cfm	Total Installed Airflow (cfm) Normal: 45 cfm	Bathroom Boost: 50 cfm
Controller ❑ Built into Fan	Brand Acme Controls (If separate)	Model # AC-1234567 (If separate)	Function (Constant Speed, Multi-speed, Intermittent) 40 cfm constant, with 60 cfm boost		
System Function and Operation	Low-speed continuous operation at 45 cfm, increases to 50 when bathroom is occupied				
Required Maintenance	Vacuum fan intake monthly.				

FIG. 12-11: SAMPLE COMPLETED OPERATION GUIDE/LABEL

8.2.3(a) A system operation guide designed for occupants (non-professionals) shall be provided to the client to explain how and why to operate the MV system.

8.2.3(b) The system operation guide or a label indicating the presence and purpose of the MV system shall be permanently posted:

8.2.3(b1) At the indoor electrical panel (or subpanel), when present, or

8.2.3(b2) When there is no indoor electrical panel, in full sight elsewhere indoors in a location approved by client

8.2.3(c) The operation guide/label format shown in Fig. 12-11 shall be utilized.

8.3. Clean-Up and Disposal Requirements

8.3.1 Decommissioning Existing Exhaust or Supply Ventilation Systems

8.3.1(a) Power supply/conductors shall be disconnected and properly terminated in a visible junction box.

8.3.1(b) Fan components (housing, fan, and ducting) that cannot be reused shall be removed and disposed of lawfully.

8.3.1(c) An existing duct, if abandoned, may be removed, and the hole may be closed off and insulated to preserve the thermal and pressure boundary.

8.3.1(d) All shell and duct leakage bypasses created by the installation of MV shall be air-sealed.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 10 years

9.1.2 DOE: Not applicable to this measure

9.2 Airflow Measuring Device

9.2.1 The device shall:

9.2.1(a) Measure airflow in CFM with a range of 10–120 CFM

9.2.1(b) Have a resolution of at least 1.0 CFM or exhaust fan flow measurement accuracy of 10%

9.2.2 Acceptable devices include:

9.2.2(a) An exhaust fan flow meter with a digital gauge (up to 124 CFM, exhaust only)

9.2.2(b) A flow capture hood

9.2.2(c) The Minneapolis Duct Blaster® with a powered capture hood (exhaust or supply with a range of 10–300 CFM)

9.2.2(d) A large vane anemometer with averaging or snapshot capability and with a display showing airflow in CFM

9.2.2(d1) Multiple readings across the fan are required without a funnel/hood; a single reading is acceptable with a funnel/hood.

9.3 MV System Components (Fans, Controllers, and Ducts)

9.3.1 General Specifications:

9.3.1(a) Components shall be:

9.3.1(a1) ASHRAE 62.2 2016–compliant for whole-house MV use

9.3.1(a2) Underwriters Laboratories (UL)–listed or equivalent

9.3.2 Fans:

9.3.2(a) Fans shall be rated for continuous operation at the required CFM.

9.3.2(b) Certification for specific fan types:

9.3.2(b1) Ceiling-mount exhaust or inline exhaust: ENERGY STAR®–certified

9.3.2(b2) Wall-mount exhaust or supply: Home Ventilating Institute (HVI)–certified

9.3.2(b3) Inline supply: ENERGY STAR– or HVI-certified

9.3.2(b4) HRV or ERV: HVI-certified

9.3.2(b5) Whole-house ventilation/kitchen exhaust combination unit: ENERGY STAR–certified

9.3.2(c) Sound (sone) level:

9.3.2(c1) Sone level certification for a continuously operating whole-house MV system shall not exceed 1.0 sone, in accordance with ASHRAE 62.2.

- Exception: The 1.0-sone limit does not apply to an in-line or remote fan with at least 4' of ducting between the fan unit and the indoor termination/grille.

9.3.3 Fan controllers shall be rated for:

9.3.3(a) Automatic, continuous, and intermittent operation

9.3.3(b) An amperage that meets or exceeds the fan load

9.3.4 Duct Materials and Insulation

9.3.4(a) All ducts shall comply with manufacturer's instructions and local code (e.g., for flame spread rating).

9.3.4(b) Rigid duct:

9.3.4(b1) Galvanized steel: Minimum 26-gauge

9.3.4(b2) Aluminum: Minimum 24-gauge

9.3.4(b3) PVC smooth plastic pipe: Minimum Schedule 80

9.3.4(c) Flexible duct:

9.3.4(c1) Semi-rigid metallic aluminum: Minimum 0.0065" thick and UL-listed 181B

9.3.4(d) Duct materials and insulation shall have a maximum flame-spread index of 25 and smoke-developed index of 50 per American Society of Testing and Materials (ASTM) E84, UL 723, or National Fire Protection Association (NFPA) 255

9.3.4(e) The minimum R-value for duct insulation shall be in accordance with Title 24, by California Energy Commission (CEC) climate zone:

9.3.4(e1) Climate zones 3, 5, 6, 7: Minimum R-value of R-6

9.3.4(e2) Climate zones 1, 2, 4, 8 – 16: Minimum R-value of R-8

9.3.5 Duct Intakes,Terminations, and Dampers

9.3.5(a) Intakes and terminations shall be constructed of aluminum, sheet metal, or ultraviolet (UV)-protected plastic and equipped with corrosion-resistant ¼"–½" weave insect/rodent screen.

9.3.5(b) A compatible metal or plastic damper shall be present in the system.

9.3.6 MV Air Filters

9.3.6(a) All air filters shall be tested to an efficiency of MERV 6 in accordance with American National Standards Institute (ANSI)/ASHRAE Standard 52.2.

9.3.6(b) Pressure drop across filter will match equipment capabilities.

9.3.7 Passive inlet vents shall have:

9.3.7(a) An indoor fresh air inlet with:

9.3.7(a1) A replaceable or washable filter for incoming air

9.3.7(a2) Manual flow control (e.g., shutter or louver) to control incoming air

9.3.7(a3) A through-the-wall sleeve/duct that is adjustable to the wall thickness

9.3.7(b) An outdoor inlet that:

9.3.7(b1) Protects from wind and precipitation (e.g., with hood and/or louvers)

9.3.7(b2) Has an insect/rodent screen

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

13. Water Heaters—Gas, Electric, and Heat Pump

Table of Contents

Water Heaters—Gas, Electric, and Heat Pump

1. MEASURE OBJECTIVES

1.1 A properly functioning, efficient, primary water heater provides economical hot water for the household.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Assessment identifies a health and safety (H&S) condition or a performance issue with the primary appliance providing heated water for the dwelling unit and

2.1.2 A qualified technician has determined the unit is repairable for <50% of the replacement cost

2.2. Install—Electric and Gas Water Heater Types

2.2.1 The dwelling does not have a primary water heater or

2.2.2 The unit is the primary water heater for the dwelling and

2.2.2(a) Does not operate as intended (e.g., it is not heating water to at least 120°F) and repair is not feasible or

2.2.2(b) Has defects that compromise its efficiency (e.g., mineral build-up or a leaking tank) and cannot be corrected or

2.2.2(c) Has an H&S condition (e.g., an electrical hazard or high carbon monoxide [CO] output) that will be resolved by installing a new water heater and repair is not feasible

2.2.2(d) A replacement water heater (e.g., for fuel switching, Energy Efficiency Upgrade, etc.) is proven by energy audit with a savings-to-investment ratio (SIR) ≥1.0

2.3. Install—Heat Pump Water Heater (HPWH)

2.3.1 The primary unit is an electric resistance water heater and is ≥10 years old and

2.3.2 Does not operate as intended (e.g., it is not heating water to at least 120°F) and repair is not feasible or

2.3.3 Has defects that compromise its efficiency (e.g., mineral build-up or a leaking tank) and cannot be corrected or

2.3.4 Has an H&S condition (e.g., an electrical hazard or water leak) that will be resolved by installing a new water heater

2.3.5 A replacement water heater (e.g.,for fuel switching, Energy Efficiency Upgrade, etc.) is proven by energy audit with an SIR ≥1.0

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1. Do Not Repair

3.1.1 Any combustion appliance safety (CAS) hazard or CAS fail cannot be corrected per Appendix A Combustion Appliance Safety Protocol

3.1.2 The appliance platform or enclosure floor under the tank is not structurally sound (see Water Heater Platform) and cannot be corrected per Section 1 General Installation Guidelines, Limited Home Repair

3.1.3 Repair would violate the Appendix E Health and Safety Requirements

3.1.4 The client refuses after measure benefits have been explained by the assessor

3.2. Do Not Install—All Water Heater Types

3.2.1 No water heater is existing in the dwelling

3.2.2 Major structural alteration, concrete work, painting, or hazardous material abatement would be required to bring the appliance to code

3.2.3 The installation guidelines for a new gas, electric, or HPWH cannot be met

3.2.4 The natural gas or propane water heater is open-combustion and located in a bedroom

3.2.4 (a) Exception: The water heater may be removed and relocated to an approved location with an approved CSD waiver.

3.2.5 Installation would violate the Appendix E Health and Safety Requirements

3.2.6 The client refuses after measure benefits have been explained by the assessor

3.3. Do Not Install—HPWH

3.3.1 The unit will be located:

3.3.1 (a) Where the ambient temperature is frequently below the manufacturer's recommended minimum

3.3.1 (b) In a mobile home or attic

3.3.1 (c) In an enclosure where the room height and volume are less than the manufacturer's recommended minimum and correction is not feasible

3.3.1 (d) In a space where cooling and noise will be an issue

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Replacement, repair, or installation of a primary water heater type is permitted when an existing primary water heater is unsafe, inoperable, or nonexistent.

4.1.1 (a) Documentation justifying any appliance replacement with a cost comparison between replacement and repair must be maintained in the client file.

4.1.2 If fuel switching is being considered, refer to Section 1 General Installation Guidelines, Fuel Switching Policy.

4.1.3 When enclosure size limitations restrict the replacement unit's capacity, sizing for a smaller unit requires a program waiver and documentation in the client file.

4.1.4 Equipment must be freeze-resistant or installed in a conditioned space.

4.1.5 The installation of a tankless water heater requires a CSD waiver.

4.1.6 When an existing water heater is not present, then the measure may be installed under Health and Safety.

4.1.7 Audited Measures

4.1.7 (a) When this measure will be installed under the Low Income Home Energy Assistance Program (LIHEAP) and an energy audit is performed, if the measure will be fully leveraged or co-funded it must comply with Appendix D Energy Audit/Priority List Protocol.

4.1.7 (b) When this measure is paid for by LIHEAP, or is co-funded with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply.

4.1.8 LIHEAP Weatherization Repair and Replacement Policy

4.1.8 (a) An existing primary water heater:

4.1.8 (a1) Qualifies for repair when it has an H&S hazard or a performance issue that can be repaired

4.1.8 (a2) Qualifies for replacement when it has an H&S hazard or performance issue that cannot be repaired, mineral build-up, or a tank that is leaking water

4.1.8(b) An existing primary water heater that is "red tagged," has a qualifying CAS issue, or is inoperable may qualify for repair or replacement.

4.1.8(c) A home with no existing water heater may qualify for appliance installation.

4.1.9 Energy Crisis Intervention Program (ECIP) Repair and Replacement Policy

4.1.9(a) Appliance repair/replacement criteria

4.1.9(a1) A water heating appliance qualifies for repair or replacement of under ECIP if it has a hazardous condition that poses a direct risk of fire or dangerous indoor air quality, including:

- High CO levels or gas leak, per the Appendix A Combustion Appliance Safety Protocol
- A condition that violates a significant state or local building code including improper clearances, inadequate combustion ventilation air, or non-conforming location and/or venting
- A ruptured tank and/or excessive water leakage from water heaters located within conditioned living areas. (Note: This does not authorize the use of ECIP funds to repair or replace leaking water heaters located in unconditioned areas, e.g., garage, exterior water heater closets.)
- Another hazardous condition, upon the pre-approval of CSD

4.1.9(b) Non-existent or inoperable appliances

4.1.9(b1) A non-existent or wholly inoperable water heater may be repaired, replaced, or installed when the applicant meets at least one of the following requirements:

- An occupant has a qualifying "medical condition" that requires temperature control. The condition must be verified by a doctor's recommendation or other objective evidence gathered at the time of application.
- An occupant is a member of a vulnerable population as identified in the LIHEAP Local Plan, and the absence of water heating creates an emergency H&S need.

4.1.10 Fuel Switching

4.1.10(a) Fuel conversion is allowed when an energy audit is conducted (with the SIR ≥1.0) per Appendix D Energy Audit/Priority List Protocol.

4.1.10(a1) For more detail, refer to the Section 1 General Installation Guidelines, Fuel Switching Policy.

4.1.10(b) An unused appliance gas line valve shall be capped.

4.1.11 Water Heater Platform

4.1.11(a) If water heater repair or replacement is required per this TRM section and the water heater platform or enclosure floor is not structurally sound, repairs to the flooring must be completed under Section 1 General Installation Guidelines, Limited Home Repair before this measure is installed.

4.1.12 When repair or replacement of a gas water heater is beyond the scope of the program, a waiver shall be sought before appliance abandonment will be offered to the client, per Appendix A Combustion Appliance Safety Protocol.

4.2. Repair Procedure

4.2.1 When a temperature and pressure valve (TPV) or drain line or automatic gas shut-off valve (AGSV) is not present or is non-conforming, a new valve and drain line must be installed when feasible.

4.2.2 When a seismic strap is not present or was not installed properly, a new strap must be installed when feasible. (See Seismic Bracing.)

4.2.3 Gas connectors shall be checked and replaced per Appendix A Combustion Appliance Safety Protocol.

4.2.4 Repair or extension of an appliance vent shall comply with Appendix A Combustion Appliance Safety Protocol.

4.3. Installation Procedure (All Types)

4.3.1 Access, Location, and Fit

4.3.1(a) Ensure the tank is installed plumb, level, and stable with information labels and controls facing outward.

4.3.1(b) Bottom support shall be structurally sized/constructed to safely support the weight of the filled appliance.

4.3.1(c) Water heaters located in garages shall be installed behind protective barriers or elevated/located out of the path of vehicles (Fig. 13-1).

4.3.1(c1) Water heaters that are not flammable vapor ignition–resistant (FVIR) units must be elevated not less than 18" above the floor or as specified by local code.

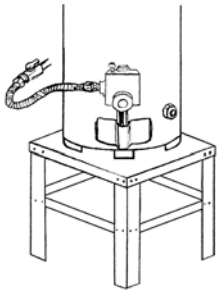


Fig. 13-1: Water Heater Elevated Above the Garage Floor

4.3.1(d) An enclosure access door shall allow replacement of the appliance.

4.3.1(e) Units installed in an attic will have a minimum access opening of 22" x 30" with an unobstructed passageway and a minimum working platform of 30" x 30" on the front service side of the water heater.

4.3.2 Seismic Bracing

4.3.2(a) Bracing must:

4.3.2(a1) Allow for required spacing around the water heater

4.3.2(a2) Be securely attached to structural framing or ledger board

4.3.2(a3) Not be installed over a water heater blanket

4.3.2(b) For tanks ≤52 gallons, two straps will be installed (Fig. 13-2):

4.3.2(b1) One within the upper third of the tank and

4.3.2(b2) One within the lower third of the tank

4.3.2(c) For tanks >52 gallons, three straps will be installed.

4.3.2(d) On gas water heaters, the lower strap shall be at least 4" above the gas control valve.

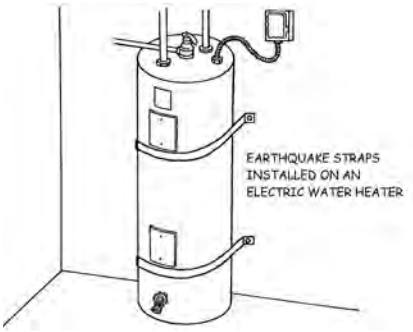


Fig. 13-2: Seismic Bracing on an Electric Water Heater ≤52 Gallons

4.3.3 Plumbing

4.3.3(a) Any existing water leaks will be repaired before installation begins.

4.3.3(b) All installed fittings and valves must be new. (Re-used materials are not allowed.)

4.3.3(c) Cross-linked polyethylene (PEX) tubing must not be installed within the first 18" of piping connected to the water heater.

4.3.3(d) Threaded fittings must be sealed with plumber's tape or non-toxic pipe joint compound.

4.3.3(e) A cold water supply shut-off valve must be installed if one is not present.

4.3.3(f) Flexible connectors must be used to connect the appliance to the rigid hot and cold water lines.

4.3.3(g) When required, install:

4.3.3(g1) Dielectric insulators on water piping connections to the tank

4.3.3(g2) An expansion tank

- Expansion tanks will only be installed when a water heater is replaced/installed and the water heater is supplied with cold water that passes through a check valve, pressure reducing valve, or backflow preventer or if required by the local code.

4.3.3(g3) A backflow prevention valve

4.3.3(g4) Heat traps on the inlet and outlet piping where not provided by the manufacturer

4.3.4 TPV

4.3.4(a) A TPV (Fig. 13-3) must be installed with a drain line that is unthreaded, points downward, and ends <24" and >6" above the surface.

4.3.4(a1) Exception: An AGSV and pressure relief valve may be used when a TPV and temperature drain line are not possible.

4.3.4(a2) The internal diameter of the line and fittings must equal or exceed the diameter of the relief valve outlet that drains fully by gravity and discharge into the drainage system or to the outdoors.

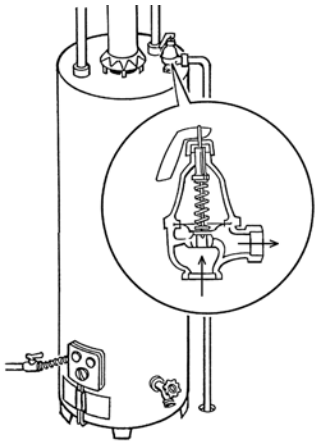


Fig. 13-3: A TPV on a Gas Water Heater

4.3.5 Drain Pan

4.3.5(a) Where damage to the dwelling would result from a leak, or when required by the local jurisdiction, a watertight pan shall be installed beneath the appliance (Fig. 13-4).

4.3.5(b) The drain pan shall have a ≥¾" drain that slopes downward to an approved location.

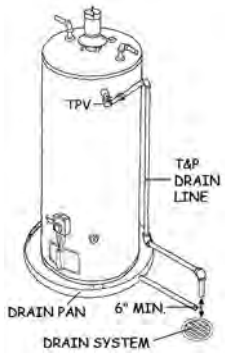


Fig. 13-4: Drain Pan Requirements

4.3.6 Pipe Insulation

4.3.6(a) Pipe insulation shall be installed on hot and cold water pipes in accordance with Section 15 Pipe Insulation—Water Heater and Exterior.

4.3.7 Water Heater Insulation

4.3.7(a) External water heater insulation shall not be installed on new water heaters unless required in accordance with Section 14 Water Heater Insulation.

4.4. Installation Procedure (Gas Storage)

4.4.1 Location Limitations

4.4.1(a) Only a direct vent water heater may be installed in an attic with a whole house fan that exhausts into the attic.

4.4.1(b) An open-combustion water heater shall not be installed in a bedroom, bathroom, or garage used as a sleeping area unless the water heater is inside a dedicated sealed closet.

4.4.2 Gas Lines, Fittings, and Valves

4.4.2(a) Non-conforming items, such as a rigid or flexible copper connector, will be replaced with code-compliant materials.

4.4.2(b) A manual gas shut-off valve will be within 6' of the appliance and in the same room in which the appliance is located.

4.4.2(c) A flexible gas connector will be located between the gas control valve and the shut-off valve.

4.4.2(d) When required by local code, a sediment trap (drip leg) will be located just ahead of the flexible gas connector.

4.4.2(e) All gas lines, flexible gas connectors, fittings, and valves will be checked for gas leaks (Fig. 13-5).

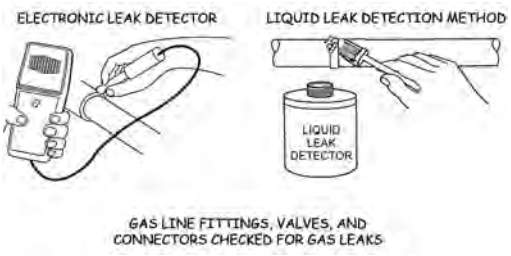


Fig. 13-5: Methods for Detecting Leaks in Gas Lines, Connectors, Fittings, and Valves

4.4.3 Combustion and Ventilation Air (CVA) Requirements

4.4.3(a) Required CVA shall be assessed and supplied as specified in Appendix A Combustion Appliance Safety Protocol.

4.4.4 Gas Vent Pipe Systems

4.4.4(a) New and existing gas venting must comply with Appendix A Combustion Appliance Safety Protocol.

4.4.4(b) Vent dampers are not allowed.

4.4.4(c) Use of Underwriters Laboratories (UL)-181 tape is not allowed as a method to seal appliance vent joints.

4.5. Installation Procedure (Electric Storage and HPWH)

4.5.1 Electrical Supply

4.5.1(a) The water heater must have:

4.5.1(a1) A dedicated, grounded electrical circuit with disconnect

4.5.1(a2) An amperage capacity of at least 125% of the nameplate rating of the water heater

4.5.1(a3) Protection by a fuse or circuit breaker of the proper amperage rating and type

4.5.1(a4) Ground-fault protection where required by code

4.5.1(b) Exposed wiring shall be enclosed in a conduit.

4.5.2 Electric Water Heater Timer

4.5.2(a) An electric water heater timer may be installed in conjunction with the new water heater per Section 16 Electric Water Heater Timers.

4.6. Installation Procedure (HPWH)

4.6.1 Installation Location Requirements

4.6.1(a) All units

4.6.1(a1) The installation location shall be free from moisture, freezing, and high temperatures, with an ambient temperature range of ≥45°F and ≤120°F.

4.6.1(a2) There shall be clearances and access for servicing, filter cleaning, and anode rod replacement.

4.6.1(b) Split units—The heat pump shall be:

4.6.1(b1) Within 50' of the tank, including 16' vertical separation or per manufacturer recommendations

4.6.1(b2) Secured to a solid level pad

4.6.1(b3) Be a minimum of 3" above the adjoining ground level

4.6.1(b4) Elevated above the pad when required per manufacturer instructions

4.6.2 Room Volume

4.6.2(a) Monolithic (“stand-alone”) units

4.6.2(a1) The room/space containing the HPWH shall be ≥700 cu. ft. or meet the manufacturer’s required minimum room volume.

4.6.2(a2) Insufficient volume may be compensated for by venting ducting to adjacent spaces or ducting the air intake and/or cold air exhaust to unconditioned space or the outdoors.

- The following methods may be used to compensate for inadequate room volume:
  - A louvered door
  - Upper and lower louvered vents
  - An upper vent and a gap ≥18 sq. in. under the door

- In small rooms (<200 cu. ft.): An upper louvered vent (the same height as the air exhaust or within 12" of it) plus a gap ≥18 sq. in. under the door or a lower vent

- When the HPWH is ducted outdoors, the ducts shall:
  - Be sized properly
  - End in a weatherproof terminal
  - Be insulated to prevent condensation
- When both the air intake and the exhaust outlet are properly ducted, minimum room venting is not required.

4.6.2(b) Split units

4.6.2(b1) The installation location shall provide the heat pump with the larger of the minimum required room volumes with unrestricted airflow:

- 800 cu. ft. minimum or
- Manufacturer's recommendations

4.6.3 Condensate Control

4.6.3(a) Condensate shall be collected and discharged above grade with a downward-sloping line to an approved drain or directly outdoors.

4.6.3(b) If a gravity drain is not possible, a condensate pump is required.

4.6.3(c) Where damage from condensate overflow is possible, install additional protection per California Plumbing Code (CPC) 814.2.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as conventional home, except as specified below.

5.1.2 Repaired/installed water heaters shall be compliant with the Department of Housing and Community Development (HCD) water heater requirements.

5.1.3 A HPWH shall not be installed in a mobile home.

5.1.4 All other requirements listed in this section apply to natural gas and propane storage water heater types. Requirements are included only where they differ from those for conventional home installation.

5.1.5 All CAS requirements unique to mobile homes shall comply with Appendix A Combustion Appliance Safety Protocol, including but not limited to the following requirements:

5.1.5(a) Combustion appliance zone (CAZ) testing

5.1.5(a1) If a water heater draws combustion air from the living space, CAZ testing shall be conducted to ensure that depressurization is not beyond the house depressurization limit.

5.1.5(b) Isolation of return air

5.1.5(b1) A permanent "isolation barrier" that provides an air-tight separation between appliance enclosures (e.g., forced air unit and water heater) must be present when a gas water heater is repaired or replaced per Appendix A Combustion Appliance Safety Protocol (Fig. 13-6).

- A non-metal water heater enclosure shall be finished with limited combustible material (e.g., 5⁄16" gypsum board or other material with flame spread rating no greater than 25).

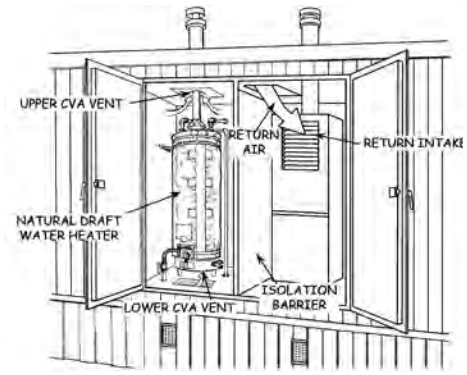


FIG. 13-6: ISOLATION OF RETURN AIR IN A MOBILE HOME SIDE-BY-SIDE APPLIANCE ENCLOSURE

5.1.5(c) A replacement water heater shall have under it a corrosion-resistant drip pan that drains to the exterior or into a plumbed drain.

5.1.5(d) If a moisture-resistant overlay (such as linoleum) is not present on the floor under the water heater, the floor shall be made moisture-resistant in accordance with HCD requirements.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 Independent Water Heaters

6.1.1(a) When an individual dwelling unit has an independently operating water heater in a multi-family building, installation requirements are the same as those for conventional homes.

6.1.2 Common Water Heater System (Serving Multiple Dwelling Units)

6.1.2(a) When a water heater serves multiple-units in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 Common Area Water Heaters

6.1.3(a) Common area installation (e.g., in a bathroom, utility room, etc. within the same thermal boundary as dwelling units) is allowed when justified by an energy audit for a multi-family whole-building project, per Appendix D Energy Audit/Priority List Protocol.

6.1.3(b) Common area installation is not allowed when only an individual unit in a multi-family building with a common water heating system will be served.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 To assess for this measure as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.1(a) The form will determine if the measure will be installed in the Audit path or the Priority List (PL) path.

7.1.1(b) When assessing this measure for the Audit path, measure feasibility will be decided by the energy audit with a Measure savings-to-investment ratio (SIR) and Dwelling SIR.

7.1.1(c) When assessing for the measure in the PL path, the feasibility will be based on building type and characteristics.

7.1.1(c1) PL measures are classified as Mandatory or Optional based on building type.

- Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.

- Optional measures may be installed only after all feasible Mandatory PL measures have been installed.

7.1.1(c2) If an energy conservation measure is not present on the PL for a specific building type, a site-specific energy audit with all feasible measures shall be conducted.

7.1.2 For the Priority List Path:

7.1.2(a) If an energy conservation measure is not present on the PL for a specific building type, a site-specific energy audit with all feasible measures shall be conducted.

7.1.2(b) All Health & Safety-related water heating repairs and replacements must be fully leveraged to an alternative funding source.

7.1.3 For the Energy Audit Path:

7.1.3(a) To install this measure with DOE funding, a site-specific energy audit is required to determine if it will be an energy conservation measure or a H&S measure.

7.1.3(b) Measure feasibility will be determined through the energy audit with a Measure savings-to-investment ratio (SIR) and Dwelling SIR.

7.1.3(b1) When the Measure SIR ≥1.0, the energy conservation measure may be paid for with DOE funds.

7.1.3(b2) When the Measure SIR <1.0 and a H&S condition exists, it is a H&S measure.

7.1.4 If a client refuses a feasible Audit path Major measure, Mandatory Priority List path, or Health & Safety measure, the entire dwelling shall be deferred.

7.1.5 When this measure is fully leveraged or co-funded with LIHEAP, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/ Priority List Protocol.

7.1.6 When an existing water heater is not present and an energy audit does not show that installation would be a cost-effective, then the measure may be installed under Health and Safety.

7.1.7 A cost benefit analysis is required to determine the optimal water heater type.

7.1.8 Mobile Home Combustion Appliances

7.1.8(a) All combustion water heaters installed or left in place after weatherization in mobile homes must meet the Manufactured Home Construction and Safety Standards, which mandates that:

7.1.8(a1) Combustion appliances must be installed to provide for the complete separation of the combustion system from the interior atmosphere of the mobile home (i.e., to draw their combustion air from outside), and be vented to outside the dwelling. See Appendix A Combustion Appliance Safety Protocol.

7.1.8(a2) Repair or replacement of combustion gas venting shall be performed when necessary to ensure proper combustion gas venting to outside the dwelling for all combustion appliances, including but not limited to gas dryers and refrigerators, furnaces, vented space heaters, and water heaters.

7.1.8(a3) Nonconformance with this requirement will require correction or removal of the appliance.

7.1.8(a4) If a client will not allow removal of an unsafe combustion appliance (primary or secondary) from the home, deferral is required.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2(a) Excerpted from 2017 SWS 7.8102.1:

7.2.2(a1) Potential for H&S hazards (e.g., backdrafting, flame rollout, obstructions) will be assessed in selecting equipment and the cost of remedying such problems will be included in any cost and benefit calculations.

7.2.2(a2) Equipment will be functional at high efficiency under all load conditions.

7.2.2(a3) Standby losses will be reduced to maximum potential.

7.2.2(a4) Fuel type will be selected based on affordability to occupant.

7.2.2(a5) The following will be determined from the occupant: lifestyle, current and future needs, space considerations, fuel options, H&S considerations, appliance options, maintenance and operation costs, return on investment concerns.

7.2.2(a6) Water heater will be selected based on performance requirements of the occupant, available fuel sources, energy efficiency, and total life cycle cost.

7.2.3 Mobile Home

7.2.3(a) Excerpted from 2017 SWS 2.0204.1:

7.2.3(a1) Blower door assisted zonal pressure diagnostics will be used to verify isolation has been achieved [to prevent combustion gasses from entering living area].

7.2.4 If weatherization installs an appliance where the existing appliance was vented into a masonry chimney, the chimney must be lined in compliance with the International Fuel Gas Code (IFGC), California Mechanical Code, and local code (if more stringent).

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 The water heater shall be tested to ensure it performs properly and safely in compliance with the manufacturer's specifications and relevant industry standards.

8.1.2 The thermostat shall be set at 120°F or as prescribed by local code.

8.1.3 Gas Water Heaters

8.1.3(a) Post-CAS appliance repair and replacement testing will be conducted in accordance with Appendix A Combustion Appliance Safety Protocol.

8.1.3(b) Appliances turned off during the installation of the water heater will be returned to standard operating condition (i.e., pilot lights will be re-lit).

8.2. Client Education

8.2.1 Occupants will be educated on the safe and efficient operation and maintenance of the system, including:

8.2.1(a) Adjustment of the water temperature and the target temperature in accordance with local code

8.2.1(b) Periodic draining and flushing

8.2.1(c) The expansion tank and backflow preventer (no occupant maintenance required)

8.2.1(d) Periodic inspection, maintenance, or replacement

8.2.1(e) Air filter cleaning for HPWHs

8.2.1(f) Warranty

8.2.1(g) Appropriate use and maintenance of the unit.

8.2.1(h) Transfer of all paperwork and operations manuals for any equipment installed by weatherization

8.2.1(i) Where combustion equipment is present, information on how to recognize depressurization and the dangers of CO poisoning associated with combustion appliance use

8.3. Clean-Up and Disposal Requirements

8.3.1 Replaced water heaters, parts, and debris will be removed from the property and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 Water Heater Repair

9.1.1(a) LIHEAP: 4 years

9.1.1(b) DOE: Not applicable to this measure

9.1.2 Water Heater Replacement/Energy Efficiency Upgrade

9.1.2(a) LIHEAP: 10 years

9.1.2(b) DOE: 13 years

9.2 Component Parts (All Water Heater Types)

9.2.1 Drain pan: Corrosion-resistant metal pan not less than 1½" in depth with a ¾" drain

9.2.2 Water Pipes

9.2.2(a) Installed water lines and valves must be lead-free.

9.2.2(b) Flexible metallic (copper and stainless steel), reinforced flexible, braided stainless steel, or polymer braided with ethylene propylene dimonomer core connectors that connect a water heater to the piping system shall comply with American Society of Mechanical Engineers (ASME) A112.18.6/Canadian Standards Association (CSA) B125.6.

9.2.2(c) Copper, copper alloy, or stainless steel flexible connectors shall not exceed 24".

9.2.3 Seismic strap kit shall:

9.2.3(a) Be an approved bracing system (strap kit) certified by the California Division of the State Architect (will have the stamp of approval on the box) and comply with California Health and Safety Code §19211

9.2.3(b) Meet or exceed the bracing requirements for the tank size

9.2.4 TPV

9.2.4(a) The line must be galvanized steel, hard drawn copper, or chlorinated polyvinyl chloride (CPVC).

9.2.4(b) The valve shall:

9.2.4(b1) Be listed and manufactured to American National Standards Institute (ANSI) Z21.22

9.2.4(b2) Meet the sizing/pressure requirements of the water heater listing

9.3 All Appliances

9.3.1 All installed water heaters shall:

9.3.1(a) Meet or exceed California Energy Commission (CEC) efficiency standards and be listed in the CEC's database of certified appliances

9.3.1(b) Be listed and labeled in accordance with local code

9.3.1(c) Be ENERGY STAR®–certified and UL-listed or equivalent

9.4 Water Heater Sizing (All Water Heater Types)

9.4.1 Water heater unit capacity must be no less than the 2022 CPC minimum "First Hour Rating" (FHR) guidelines, as shown in Table 13-1.

Table 13-1: Minimum Capacity for Water Heaters (FHR)

Number of Bathrooms	1–1.5			2–2.5				3–3.5			
Number of Bedrooms	1	2	3	2	3	4	5	3	4	5	6
FHR*	38	49	49	49	62	62	74	62	74	74	74

*FHR is the water heater capacity expressed in gallons on the yellow EnergyGuide label. It is the amount of hot water the heater can supply per hour (starting with a tank full of hot water).

9.5 Mobile Home Water Heaters (Electric, Natural Gas, and Propane Storage Types)

9.5.1 A gas water heater is required to be direct vent type when located inside the living space).

9.5.2 The water heater shall have a maximum standby loss of 7% (25–35 gallons) or 8% (>35 gallons).

9.5.3 Efficiency requirements from Conventional Home and Multi-Family Water Heaters (Electric, Natural Gas, and Propane) shall apply.

9.6 Conventional Home and Multi-Family Water Heaters (Electric, Natural Gas, and Propane)

9.6.1 Storage Electric Resistance Water Heaters

9.6.1(a) All electric water heaters shall have a minimum uniform energy factor (UEF) as shown in Table 13-2.

Table 13-2: Minimum UEF for Storage Electric Water Heaters, Based on FHR*

Tank Volume (Gallons)	FHR 18–<51	FHR 51–<75	FHR ≥75
30	0.92	0.92	0.93
40	0.91	0.92	0.93
50	0.91	0.92	0.93
55	0.91	0.92	0.93

*Based on Table F-2 from the CEC, Title 20, January 2020

9.6.2 Storage Natural Gas or Propane Hot Water Heaters

9.6.2(a) All installed natural gas or propane storage-type water heaters must:

9.6.2(a1) Be low–nitrogen oxide (NOx) burner systems when required by local code

9.6.2(a2) Have an FVIR combustion chamber when the unit to be replaced is an open-combustion unit

9.6.2(a3) Have a minimum UEF as shown in Table 13-3

Table 13-3: Minimum UEF for Storage Gas Water Heaters, Based on FHR*

Tank Volume (Gallons)	FHR 18–<51	FHR 51–<75	FHR ≥75
30	0.54	0.60	0.65
40	0.52	0.58	0.64
50	0.50	0.56	0.63
55	0.49	0.55	0.62
60	0.74	0.77	0.79

*Title 24 prescriptive requirement published in Water Heater Efficiency Guide, CEC, October 2022

9.6.3 Gas Pipes

9.6.3(a) All valves and flexible connectors must be new.

9.6.3(b) Gas valves will be UL-listed (or equivalent) and American Gas Association (AGA)- or CSA-certified.

9.6.3(c) Flexible connectors will be listed (e.g., by the International Association of Plumbing and Mechanical Officials [IAPMO]) epoxy-coated or stainless steel units.

9.6.3(d) Fuel gas piping will comply with latest adopted California Mechanical Code (CMC).

9.6.3(e) Copper gas lines and butt-soldered joints are not allowed.

9.6.4 Gas Water Heater Vent System

9.6.4(a) Will be composed of UL-listed vent connectors, components, and Type B vent pipes.

9.7 Conventional Home HPWH

9.7.1 Water heaters shall:

9.7.1(a) Be compliant with Northwest Energy Efficiency Alliance Advanced (NEEA) Water Heater Specification Tier 3 or higher

9.7.1(b) Have a minimum UEF according to the corresponding climate zone as listed in Table 13-4:

TABLE 13-4: MINIMUM UEF BY CLIMATE ZONE*

Climate Zone	Minimum UEF
1	2.82
2	2.82
3	2.82
4	2.87
5	2.82
6	2.47
7	2.61
8	2.47
9	2.47
10	2.47
11	2.61
12	2.87
13	2.61
14	2.61
15	2.47
16	≥3.00 plus a solar water heating system with solar saving fraction ≥0.4
*Title 24 prescriptive requirement published in Water Heater Efficiency Guide, California Energy Commission, October 2022	

9.7.2 Ducts and terminals shall be heating, ventilation, and air conditioning–quality sheet metal ducts or UL-listed flexible metal ducts with terminals designed to protect against moisture entry and pest intrusion (i.e., screened).

10. WARRANTY

10.1 Repair—All Water Heater Types

10.1.1 Parts—90 days

10.1.2 Contractor—1 year

10.2 Replacement/Installation—Gas and Electric Water Heaters

10.2.1 Manufacturer—5 years (tank)/1 year (other)

10.2.2 Contractor—1 year

10.3 Installation—HPWH

10.3.1 Manufacturer—6 years

10.3.2 Contractor—1 year

14. Water Heater Insulation

Table of Contents

Water Heater Insulation

1. MEASURE OBJECTIVES

1.1 Water heater tank insulation reduces standby heat loss.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable for this measure.

2.2. Install

2.2.1 A single-family or multi-family central water heater supplies hot water to the dwelling unit(s) to be served and

2.2.2 No insulation is present, or insulation is substantially damaged and not effectively insulating the heater and

2.2.3 External insulation is not prohibited by the manufacturer and

2.2.4 The internal insulation R-value is:

2.2.4(a) <R-12 for a gas water heater or

2.2.4(b) <R-16 for an electric water heater

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1. All Water Heater Types

3.1.1 Prohibited by the tank manufacturer

3.1.2 Any combustion appliance safety (CAS) hazard, CAS fail, or electrical hazard cannot be corrected per Appendix A Combustion Appliance Safety Protocol

3.1.3 The water heater is the tankless type

3.1.4 A water line leak or electrical hazard is present, or the water heater requires repair or replacement and cannot be corrected under Section 13 Water Heaters—Gas, Electric, and Heat Pump

3.1.5 The temperature and pressure relief valve (TPV) is non-compliant and cannot be corrected under Section 13 Water Heaters—Gas, Electric, and Heat Pump

3.1.6 The tank is located in an unprotected area that is exposed to the weather

3.1.7 The appliance platform or enclosure floor under the tank is not structurally sound (see Section 13 Water Heaters—Gas, Electric, and Heat Pump) and cannot be corrected per Section 1 General Installation Guidelines, Limited Home Repair

3.1.8 Three insulation blanket straps physically cannot be installed

3.1.9 Polyvinyl chloride (PVC) piping is present on the cold or hot water line to or from the tank

3.1.10 Installation would violate the Appendix E Health and Safety Requirements

3.1.11 The client refuses after measure benefits have been explained by the assessor

3.2. Electric Water Heaters

3.2.1 Hazardous electrical wiring is present

3.2.2 The overcurrent protection is inadequate

3.2.3 A thermostat cover plate is missing

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 The internal insulation R-value shall be determined, if possible.

4.1.1(a) If the R-value is not printed on the identification (ID) label, the model number shall be used to check it (e.g., in the owner's manual or on the manufacturer's website).

4.1.2 Seismic (Earthquake) Bracing

4.1.2(a) Seismic bracing, if added, shall be done prior to installing water heater insulation. (See Section 13 Water Heaters—Gas, Electric, and Heat Pump.)

4.1.2(b) Seismic straps and braces shall not be installed over insulation.

4.1.2(c) Braces shall fit tightly to the body of the tank.

4.1.2(d) The blanket shall be slit to fit around the straps and braces.

4.1.2(e) All slits shall be securely taped closed.

4.1.3 Clearance

4.1.3(a) All water heaters:

4.1.3(a1) The tank must be more than 12" from a stove, range, or cooktop.

4.1.3(a2) The front clearance shall be sufficient to allow the enclosure door to close freely with the blanket installed.

4.1.3(b) Gas water heaters:

4.1.3(b1) Front clearance shall be at least 4" between the door and the tank prior to insulation installation (Fig. 14-1).

- Exception: 3" of front clearance is acceptable in induced-draft and closed-combustion water heaters when allowed by the manufacturer.

4.1.3(b2) At least 3" of clearance is required from the blanket and tape to the edge of:

- The burner access opening
- The draft hood opening

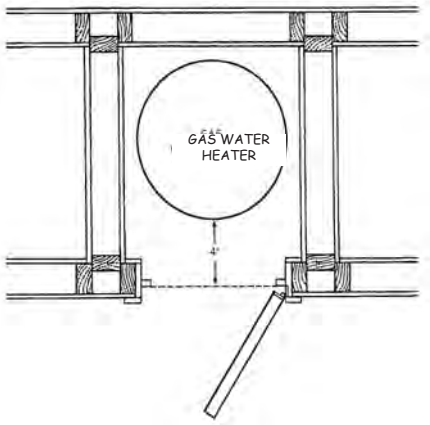


FIG. 14-1: GAS WATER HEATER CLEARANCE REQUIREMENT

4.1.4 Coverage

4.1.4(a) Gas water heaters:

4.1.4(a1) The top of the tank shall not be insulated on natural-draft units (Fig. 14-2).

4.1.4(a2) A top cover shall be installed on closed-combustion and induced-draft/power-vented units, with 3" of clearance from flue system and inducer fan.

4.1.4(a3) Side insulation shall:

- Completely surround the tank to provide 100% coverage
- Extend from the top of the tank to the bottom of the drain valve neck
- Not extend beyond the bottom of the tank or restrict combustion air access in any way

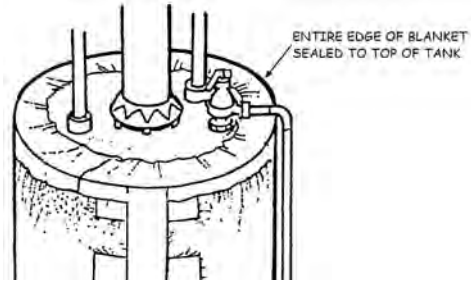


FIG. 14-2: NATURAL DRAFT GAS UNIT—NO TOP COVER

4.1.4(a4) The gas control valve and other components (Fig. 14-3) shall not be covered by a blanket, tape, or a strap.

4.1.4(a5) Combustion air supply

- Combustion and ventilation air must be adequate, and inlets must be unobstructed.

- When the tank is located in an attic with loose-fill insulation present, blocking shall be installed to comply with Section 37 Attic and Ceiling Insulation.

4.1.4(a6) The identification label, safety information, and lighting instructions shall be identified and made easily accessible.

- A flap (top-hinged when possible) shall be cut in the blanket to provide access (Fig. 14-3).
- Flaps shall be held closed with tape.
  - A minimum of one tape strip shall be installed along the slit opposite the flap hinge.
  - All slits longer than 12" shall be secured with tape installed lengthwise along the slit.
- Flaps shall be labeled in permanent ink to identify what is underneath. (e.g., safety instructions).

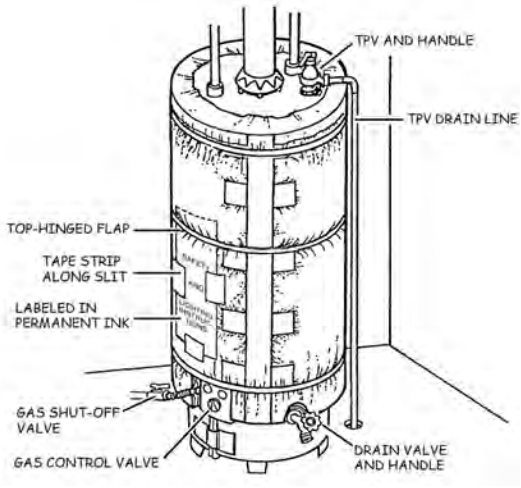


FIG. 14-3: GAS WATER HEATER COVERAGE

4.1.4(b) Electric water heaters:

4.1.4(b1) The top of tank shall be completely covered with insulation (Fig. 14-4).

4.1.4(b2) Side insulation shall:

- Completely surround the tank to provide 100% coverage
- Extend down to the bottom of the drain valve neck

4.1.4(b3) The locations of the upper and lower thermostats and ID labels will be marked and made easily accessible.

- The blanket shall be cut on the sides and bottom to create a top-hinged flap over the ID label and each thermostat cover plate.
- Each flap shall be labeled in permanent ink to identify what is underneath (e.g., thermostat or ID label) (Fig. 14-5).
- A minimum of one tape strip shall be installed along the slit opposite the flap hinge.
- All slits longer than 12" shall be secured with tape installed lengthwise along the slit.

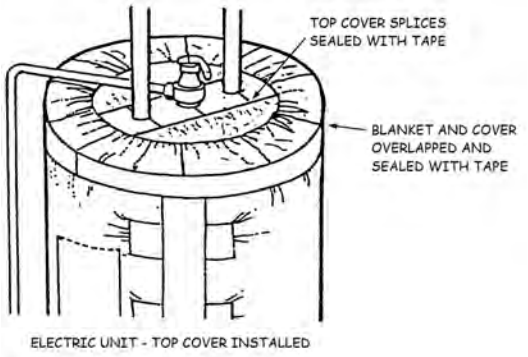


FIG. 14-4: ELECTRIC UNIT—TOP OF TANK COVERED

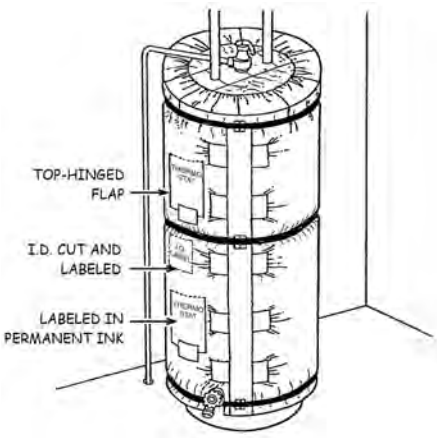


FIG. 14-5: ELECTRIC WATER HEATER SAFETY INSTRUCTIONS

4.1.5 Top Seams and Edges

4.1.5(a) Gas water heaters:

4.1.5(a1) The top edge of the blanket shall be sealed to the top of the tank with tape around the entire perimeter of the tank (Fig. 14-2).

4.1.5(b) Electric water heaters:

4.1.5(b1) The perimeter of the top cover shall be sealed to the top edge of the blanket with tape (Fig. 14-4).

4.1.5(b2) All seams and slits in the cover shall be sealed with tape.

4.1.6 Side Seams and Bottom Edge

4.1.6(a) Cross straps:

4.1.6(a1) All splices shall be reinforced with cross straps of tape at least 10" long and be located a maximum of 18" apart (Fig. 14-6).

4.1.6(b) Splices with flaps of facing material:

4.1.6(b1) Flaps shall be at least 2" wide.

4.1.6(b2) Pieces shall be joined securely and sealed with tape the full length of the flap.

4.1.6(c) Splices without flaps:

4.1.6(c1) The blanket shall be overlapped at least 2".

4.1.6(c2) Seams shall be sealed with tape the full length of the splice.

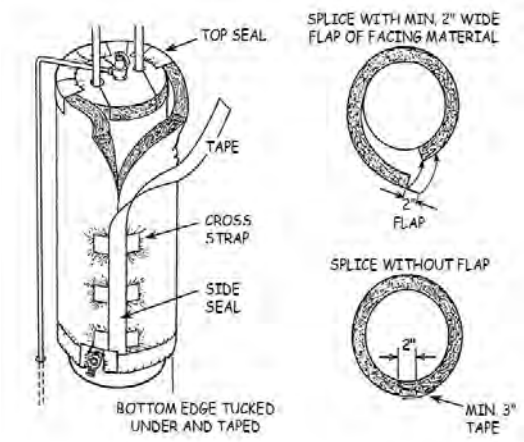


Fig. 14-6: Top, Sides, and Flaps Sealed with Tape

4.1.6(d) Bottom edge on water heaters within the living space (not in an enclosure):

4.1.6(d1) The bottom edge of the fiberglass shall not be left exposed.

- The bottom edge shall be sealed to the tank with tape, or
- The facing shall be tucked under and permanently taped in place

4.1.7 Blanket Straps and Buckles

4.1.7(a) A minimum of three blanket straps shall be installed in addition to tape (Fig. 14-7).

4.1.7(b) Straps shall be secured with buckles or other mechanical strap locks; tying of straps is not allowed.

4.1.7(c) Straps shall be installed as follows:

4.1.7(c1) One strap within the top ⅓ of the blanket

4.1.7(c2) One strap within the bottom ⅓ of the blanket

4.1.7(c3) One strap midway on the blanket

4.1.7(d) Straps shall not be placed over thermostat cover plates, controls, valves, or the burner access door.

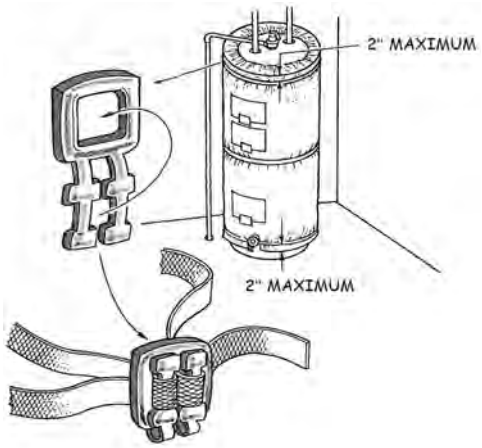


Fig. 14-7: Water Heater Blanket Strap and Buckle

4.1.7(e) Straps shall provide a snug fit with minimum compression of the blanket under the straps only.

4.1.8 Temperature and Pressure Protection

4.1.8(a) For all water heaters:

4.1.8(a1) A TPV shall be present and located within 6" of the tank.

4.1.8(a2) Valves shall not be covered by the blanket

4.1.8(a3) The end of the TPV drain line shall:

- Be open and unobstructed (not capped or plugged)

- Not be covered or obstructed by the blanket

4.1.8(a4) If a TPV drain line is not present and cannot be corrected under Section 13 Water Heaters—Gas, Electric, and Heat Pump, insulation can be installed but shall not obstruct the valve outlet.

4.1.8(b) For gas water heaters:

4.1.8(b1) The tank shall be protected by a TPV or automatic gas shutoff valve (AGSV) located within 6" of the tank.

4.1.8(b2) The AGSV (if present) and gas pipe/flex to/from the AGSV shall not be covered.

4.1.9 Tank Drain Valve

4.1.9(a) For all water heaters:

4.1.9(a1) The tank drain valve shall not be covered by the blanket.

4.1.9(a2) A minimum ½" clearance is required between the blanket and the valve.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 Common Water Heater System

6.1.3(a) Installation of insulation on a common water heater (i.e., a water heater that serves multiple dwelling units) is not allowed when only an individual unit in a multi-family building will be served.

6.1.4 Common Area Water Heaters

6.1.4(a) Common area installation (e.g., installation on a water heater located in a kitchen, laundry room, hallway, etc. within the same thermal boundary as the dwelling units) is not allowed when only an individual unit in a multi-family building will be served.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 To assess for this measure as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.1(a) The form will determine if the measure will be installed in the Audit path or the Priority List (PL) path.

7.1.1(b) When assessing for this measure for the Audit path, this measure is a DOE Audit path, General Heat Waste (GHW) measure. The measures in this category include air filters, faucet aerators, low-flow showerheads, thermostatic showerheads, water heater insulation (blankets), and water heater pipe insulation.

7.1.1(b1) When installing this measure as part of the Audit path work scope, a Measure SIR and Dwelling SIR are not required.

7.1.1(b2) The maximum installed cost for all Audit path, GHW measures is $250.

7.1.1(c) When assessing for the measure in the PL path, the feasibility will be based on building type and characteristics.

7.1.1(c1) PL measures are classified as Mandatory or Optional based on building type.

- Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.
- Optional measures may be installed only after all feasible Mandatory PL measures have been installed.

7.1.1(c2) This measure is a PL path Optional water measure. The measures in this category include faucet aerators, low-flow showerheads, thermostatic shower heads, water heater blankets, and water heater pipe insulation.

7.1.1(c3) When installing this measure as part of the PL path work scope, a Measure SIR and Dwelling SIR are not required.

7.1.1(c4) The maximum installed cost for all PL water measures is $250.

7.1.1(d) When this measure is paid for by LIHEAP, or is cost-shared with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/Priority List Protocol.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family and Multi-Family Central Systems

7.2.2(a) Excerpted from SWS 7.8102.2:

7.2.2(a1) If additional tank insulation is installed, it will be rated a minimum of R-11 and will be installed to manufacturer specifications.

- Exception: When tank manufacturer prohibits the installation of an external blanket, insulation shall not be installed.

7.2.2(b) Excerpted from SWS 7.8102.9:

7.2.2(b1) Non-fired storage tank

- All piping and fittings will be insulated with fixed insulation to IECC [International Energy Conservation Code] or ASHRAE [American Society of Heating, Refrigerating, and Air-Conditioning Engineers] 90.1, at a minimum.
- Tanks will be insulated to a minimum of R-12.5.

7.2.2(c) Excerpted from SWS 7.8103.1:

7.2.2(c1) Water heater storage tanks shall have a minimum R-value of R-24.

7.2.3 Mobile Home

7.2.3(a) Requirements for mobile homes are the same as those for single-family homes.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Ensure water heater blanket:

8.1.1(a) Is installed securely and properly

8.1.1(b) Does not impede safe operation of the water heater

8.2. Client Education

8.2.1 Occupants/building management will be educated on how to access the information located beneath the blanket flaps.

8.3. Clean-Up and Disposal Requirements

8.3.1 All packing materials and replaced insulation shall be removed from the property and disposed of properly.

8.3.2 Furniture and other household items moved for installation work shall be returned to their original positions.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 4 years

9.1.2 DOE: 13 years

9.2 Blanket Material

9.2.1 Maximum flame-spread index of 25 and maximum smoke-developed index of 50, per American Society for Testing and Materials (ASTM) E84, or Underwriters Laboratories (UL) 723, or National Fire Protection Association (NFPA) 255

9.2.2 Mineral fiber only, with vinyl or fiber-reinforced foil facing

9.2.3 LIHEAP minimum R-value: R-6

9.2.4 DOE storage water heaters: Minimum R-11

9.2.5 DOE non-fired central units: Minimum R-12.5

9.3 Straps and Buckles

9.3.1 Maximum flame-spread index of 25 and maximum smoke-developed index of 50 per ASTM E84, or UL 723, or NFPA 255

9.3.2 Polypropylene blanket straps and compatible buckles or other mechanical strap locks

9.4 Tape

9.4.1 Maximum flame-spread index of 25 and maximum smoke-developed index of 50 per ASTM E84, UL 723, or NFPA 255

9.4.2 Vinyl or fiber-reinforced foil compatible with or the same material as the facing. (See Blanket Material.)

9.4.3 Minimum width 3"

9.4.4 Duct tape is not allowed

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

15. Pipe Insulation—Water Heater and Exterior

Table of Contents

Pipe Insulation—Water Heater and Exterior

1. MEASURE OBJECTIVES

1.1 Water heater pipe insulation saves energy by reducing the heat loss from water pipes.

1.2 Exterior pipe insulation protects exterior water entrance pipe and valves from freeze damage.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Trimming and/or securing of existing water pipe insulation to prevent a fire hazard is required if adequate clearances are not met and the client is not physically capable of making the corrections. Refer to Section 1 General Installation Guidelines, Limited Home Repair.

2.2. Install

2.2.1 Water Heater Pipe Insulation

2.2.1(a) The water heater is a storage or tankless unit and

2.2.1(b) Exposed hot and cold water piping from the water heater is present or

2.2.1(c) The existing insulation is substandard, e.g. with gaps, reduced R-value, water damage, or physical damage

2.2.2 Exterior Pipe Insulation

2.2.2(a) Water entrance pipe is not insulated, or existing insulation is not serviceable (e.g., degraded, damaged, lacking in integrity, etc.)

2.2.2(b) The piping is free from water leaks and properly secured

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1. Do Not Repair or Install

3.1.1 Water Heater Pipe Insulation

3.1.1(a) The water heater or piping does not provide hot water to the dwelling being served

3.1.1(b) The cold or hot water pipe is inaccessible

3.1.1(c) Less than 1' of continuous insulation would be installed

3.1.1(d) Pipe configuration does not allow proper installation

3.1.1(e) Any combustion appliance safety (CAS) hazard or CAS fail cannot be corrected per Appendix A Combustion Appliance Safety Protocol

3.1.1(f) A water line leak or electrical hazard is present, or the water heater requires repair or replacement that cannot be corrected per Section 13 Water Heaters—Gas, Electric, and Heat Pump.

3.1.1(g) Polyvinyl chloride (PVC) piping is present on the cold or hot water line to or from the tank

3.1.1(h) The appliance platform or enclosure floor under the tank is not structurally sound (see Section 13 Water Heaters—Gas, Electric, and Heat Pump) and cannot be corrected per Section 1 General Installation Guidelines, Limited Home Repair

3.1.1(i) The tank piping is located in an unprotected area that is exposed to the weather

3.1.1(j) Installation would violate the Appendix E Health and Safety Requirements

3.1.1(k) The client refuses after measure benefits have been explained by the assessor

3.1.2 Exterior Pipe Insulation

3.1.2(a) The water entrance pipe has serviceable pipe insulation already in place

3.1.2(b) The water entrance pipe is leaking or is in substandard condition

3.1.2(c) Installation would violate the Appendix E Health and Safety Requirements

3.1.2(d) The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Water Heater Pipe Insulation

4.1.1 (a) Existing water heater repair and replacement or correction of a CAS hazard, CAS fail, or electrical fail shall be completed before water heater pipe insulation is installed.

4.2. Installation Procedure

4.2.1 Water Heater Pipe Insulation

4.2.1 (a) Insulation shall be installed on hot and cold water pipes that are:

4.2.1 (a1) Connected to the water heater (including tankless)

4.2.1 (a2) Rigid or flexible lines

4.2.1 (a3) Free of leaks

4.2.1 (a4) Under continuous water pressure

4.2.1 (b) Coverage

4.2.1 (b1) Insulation shall cover all accessible portions of the first 5' of the cold water pipe, all accessible hot water pipe, and all pipe subject to freezing.(e.g., exterior split-system heat pump pipes) (Fig. 15-1).

4.2.1 (b2) Insulation shall begin at the tank unless prevented by the clearance requirement. (See Clearances and Coverage Restrictions.)

4.2.1 (b3) Elbows and curves shall be covered without gaps.

4.2.1 (b4) Valves shall be covered, but handles shall be left clear and unobstructed.

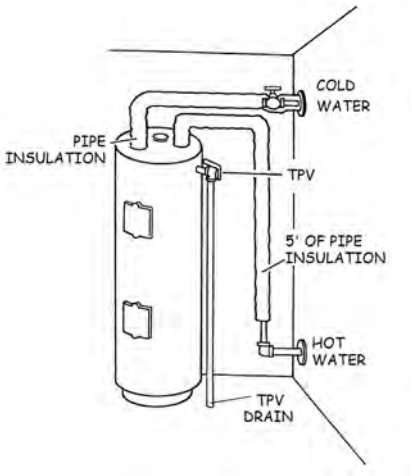


Fig. 15-1: Pipe Insulation Coverage Requirements

4.2.1 (c) Coverage Restrictions

4.2.1 (c1) For all units, insulation shall not cover:

- The temperature and pressure valve (TPV) or automatic gas shutoff valve (AGSV)
- Valve handles
- Control and safety devices
- The TPV drain line
- Leaking pipes

4.2.1 (d) Clearances

4.2.1 (d1) Pipe insulation shall be placed to maintain the following clearances from gas unit components, or as specified by the pipe listing.

- Single-wall pipe: 6" clearance
- Type B double-wall pipe: 1" clearance
- Type L double-wall pipe: 3" clearance
- Draft hood opening: Shall not be obstructed

4.2.1 (e) Pre-Formed Pipe Insulation

4.2.1 (e1) Slits shall be positioned downward on horizontal pipe.

4.2.1 (e2) Insulation shall be mitered and/or notched on bends, corners, and joints to provide complete closure without gaps (Fig. 15-2).

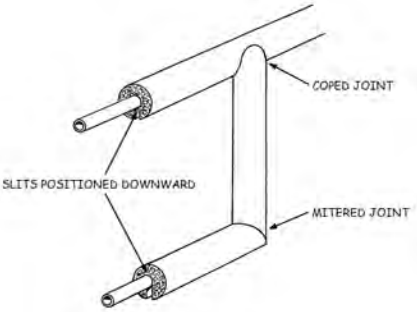


Fig. 15-2: Proper Installation of Pre-Formed Insulation

4.2.1 (f) General Attachment Requirements

4.2.1 (f1) Insulation shall be firmly secured with ultraviolet (UV)-rated plastic cable ties, tape, wire, or sleeves (Fig. 15-3).

4.2.1 (f2) All slits and joints shall be glued or taped to achieve complete closure.

4.2.1 (f3) Tape shall be used on bends, 90º elbows, and joints.

4.2.1 (f4) Attachments shall be installed:

- A maximum of 12" apart and
- Within 1" of each end
- With approved adhesives
- With ¼" total compression at ends only

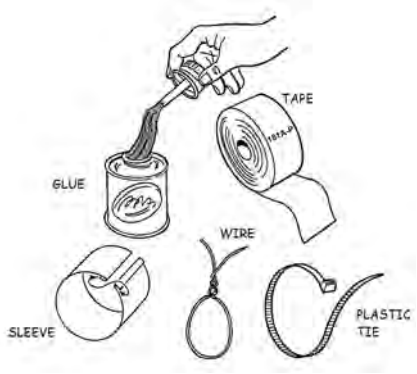


FIG. 15-3: INSULATION ATTACHMENT OPTIONS

4.2.1 (f5) Sleeves for attachment shall not compress insulation.

4.2.2 Exterior Pipe Insulation

4.2.2 (a) Pipe insulation shall be installed on all exposed, outdoor piping, joints, elbows, valve bodies, etc.

4.2.2 (b) Insulation shall not interfere with valve operation.

4.2.2 (c) Insulation material shall be cut and folded or otherwise molded to completely cover all sections of the system without compressing the insulation or allowing gaps to occur in the insulation.

4.2.2 (d) If the diameter of fittings at connections and corners is larger than the piping, those fittings shall be covered with insulation that matches their outside diameter.

4.2.2 (e) Insulation shall be firmly secured to the piping system with weather-resistant and UV-resistant covering and fasteners.

4.2.2 (f) Pre-formed pipe insulation

4.2.2 (f1) Slits shall be positioned toward the building

4.2.2 (f2) Insulation shall be mitered and/or notched on bends, corners, and joints to provide complete closure without gaps.

4.2.2 (f3) Insulation shall be firmly secured.

4.2.2 (g) Foam insulation

4.2.2 (g1) All slits, and joints shall be glued or taped to achieve complete closure.

4.2.2 (g2) Attachments shall be installed:

- A maximum of 12" apart and within 1" of each end
- With ¼" total compression at ends only

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 Water Heater Pipe Insulation

6.1.1 (a) When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.1 (b) When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.1(c) Installation of pipe insulation on a common water heater (i.e., a water heater that serves multiple dwelling units) is not allowed when only an individual unit in a multi-family building will be served.

6.1.1(d) Common area installation (e.g., installation of pipe insulation on a water heater located in a kitchen, laundry room, hallway, etc. within the same thermal boundary as the dwelling units) is not allowed when only an individual unit in a multi-family building will be served.

6.1.2 Exterior Pipe Insulation

6.1.2(a) When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2(b) There are no multi-family whole-building installation requirements. The conventional home (single-family) criteria apply to all multi-family whole-building installations.

6.1.2(c) Common area installation is not allowed when only an individual unit in a multi-family building will be served.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 Water Heater Pipe Insulation

7.1.1(a) To assess for this measure as part of a DOE workscope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.1(a1) The form will determine if the measure will be installed in the Audit path or the Priority List (PL) path.

7.1.1(a2) When assessing for this measure for the Audit path, this measure is a DOE Audit path, General Heat Waste (GHW) measure. The measures in this category include air filters, faucet aerators, low-flow showerheads, thermostatic showerheads, water heater insulation (blankets), and water heater pipe insulation.

- When installing this measure as part of the Audit path work scope, a Measure SIR and Dwelling SIR are not required.
- The maximum installed cost for all Audit path, GHW measures is $250.

7.1.1(a3) When assessing for the measure in the PL path, the feasibility will be based on building type and characteristics.

- PL measures are classified as Mandatory or Optional based on building type.
  - Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.
  - Optional measures may be installed only after all feasible Mandatory PL measures have been installed.
- This measure is a PL path Optional water measure. The measures in this category include faucet aerators, low-flow showerheads, thermostatic shower heads, water heater blankets, and water heater pipe insulation.
- When installing this measure as part of the PL path work scope, a Measure SIR and Dwelling SIR are not required.
- The maximum installed cost for all PL water measures is $250.

7.1.1(b) When this measure is paid for by LIHEAP, or is cost-shared with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/Priority List Protocol.

7.1.2 Exterior Pipe Insulation

7.1.2(a) This is not a DOE measure.

7.2. Installation Requirements

7.2.1 Water Heater Pipe Insulation

7.2.1(a) Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.1(b) Single-Family

7.2.1(b1) Excerpted from 2017 SWS 7.8102.2:

- The first 6' of inlet and outlet piping will be insulated in accordance with manufacturer specifications.
- Combustible pipe insulation must maintain a minimum clearance of 6" from gas water heater draft hood.

7.2.1(c) Mobile Home

7.2.1(c1) Requirements for mobile homes are the same as those for single-family homes.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Ensure:

8.1.1(a) The insulation covers all applicable areas

8.1.1(b) The attachment method complies with this standard

8.1.1(c) Proper clearances are maintained

8.2. Client Education

8.2.1 None

8.3. Clean-Up and Disposal Requirements

8.3.1 Scraps and debris shall be removed and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 Water Heater Pipe Insulation

9.1.1(a) LIHEAP: 10 years

9.1.1(b) DOE: 13 years

9.1.2 Exterior Pipe Insulation

9.1.2(a) LIHEAP: 10 years

9.1.2(b) DOE: Not applicable to this measure.

9.2 All materials shall have a maximum flame-spread index of 25 and maximum smoke-developed index of 450 per American Society of Testing and Materials (ASTM) E84, Underwriters Laboratories (UL) 723, or Uniform Building Code (UBC) Standard 8-1.

9.3 Glue shall be compatible with insulation material and manufacturer’s instructions.

9.4 Water heater pipe insulation material shall:

9.4.1 Be resistant to degradation from moisture, ultra-violet light, and extremes in temperature, or a jacket or facing.

9.4.2 Be made of pre-formed foam (e.g. closed-cell polyethylene) that conforms to ASTM C534

9.4.2(a) The inside diameter of the pre-formed material shall be appropriate for the size of the pipe being insulated

9.4.3 Be rated for temperatures up to 180°F

9.4.4 Have a minimum thickness per Table 15-1:

TABLE 15-1: PIPE INSULATION THICKNESS

Pipe Diameter	Thickness	Min. R-Value
<1"	1"	R-7.7
1"–<1½"	1½"	R-12.5
1½"–<4"	1½"	R-11

9.5 Pipe Insulation Types Not Allowed

9.5.1 Sheet or semi-molded insulation

9.5.2 Heat tape or strap insulation

9.6 Exterior pipe insulation shall be either:

9.6.1 Pre-formed fiberglass insulation

9.6.1(a) Self-sealing lap fiberglass pipe insulation, rated for exterior use

9.6.1(b) Designed to be secured and sealed to be watertight with exterior-rated materials

9.6.2 Pre-formed foam insulation:

9.6.2(a) Made of pre-formed foam (e.g. closed-cell polyethylene) that conforms to ASTM C534

9.6.2(a1) The inside diameter of the pre-formed material shall be appropriate for the size of the pipe being insulated

9.7 Tape shall be:

9.7.1 Specified by insulation manufacturer or

9.7.2 Minimum 2"-wide pressure-sensitive metallic tape labeled UL 181A-P or UL 181B-FX

9.7.2(a) Cloth duct tape and electrical tape are not allowed.

9.8 Ties shall be:

9.8.1 UV-rated plastic cable ties or

9.8.2 Corrosion-resistant wire and metal sleeves

10. WARRANTY

Install

10.1 Contractor—1 year

10.2 Manufacturer—1 year

16. Electric Water Heater Timers

Table of Contents

Electric Water Heater Timers

1. MEASURE OBJECTIVES

1.1 An electric water heater timer saves energy by providing power to the water heater only during specified periods.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure

2.2. Install

2.2.1 An electric water heater is present and

2.2.2 No operable timer is present

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The water heater does not provide hot water to the dwelling being served

3.2 An existing electric water heater timer is operable and functioning properly

3.3 The electric water heater:

3.3.1 Does not use electric resistance heating coils or

3.3.2 Exceeds 7.5 kilowatt (kW) electrical capacity

3.4 A water line leak or electrical hazard is present, or the water heater requires repair or replacement that cannot be corrected per Section 13 Water Heaters—Gas, Electric, and Heat Pump

3.5 Polyvinyl chloride (PVC) piping is present on the cold or hot water line to or from the tank

3.6 The appliance platform or enclosure floor under the tank is not structurally sound (see Section 13 Water Heaters—Gas, Electric, and Heat Pump) and cannot be corrected per Section 1 General Installation Guidelines, Limited Home Repair

3.7 Installation would violate the Appendix E Health and Safety Requirements

3.8 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Electrical Wiring

4.1.1(a) Wiring shall be properly sized for the electrical load.

4.1.1(b) The water heater timer shall be connected to the fuse box or electric service breaker with proper overcurrent protection.

4.1.1(c) Exposed wiring shall be enclosed in conduit/raceway.

4.1.2 Location

4.1.2(a) When the water heater is not in an outdoor-rated enclosure, it must be in a protected area (not exposed to weather):

4.1.2(a1) Indoors or

4.1.2(a2) Inside an outdoor enclosure or

4.1.2(a3) In an outdoor covered area where the roof or overhang extends away a minimum of 4' on all exposed sides

4.1.2(b) Outdoor installation of the timer is allowed only when access to the timer would otherwise be difficult for occupants (e.g., when the tank is located under the house or when there is restricted crawlspace access).

4.1.2(c) The timer and housing shall be rated for the location in which they are mounted (e.g., damp or wet location).

4.1.2(d) The electrical wiring shall be protected from the weather (e.g., with waterproof conduit and fittings) and properly secured.

4.2. Installation Procedure

4.2.1 Mounting the Timer

4.2.1(a) The timer shall be securely mounted:

4.2.1(a1) To framing members or solid wood sheathing with screws or

4.2.1(a2) To gypsum with anchoring devices (e.g., drive anchors, “molly bolts” or other expansion anchors) (Fig. 16-1)

4.2.1(b) Mounting of the timer on the water heater is acceptable only when allowed by the manufacturer’s instructions.

4.2.2 Timer Setting

4.2.2(a) The timer setback period shall be minimum 8 hours.

4.2.2(b) Program a minimum of two setback periods per 24-hour day.

4.2.2(c) Allow a minimum of 2 hours between settings.

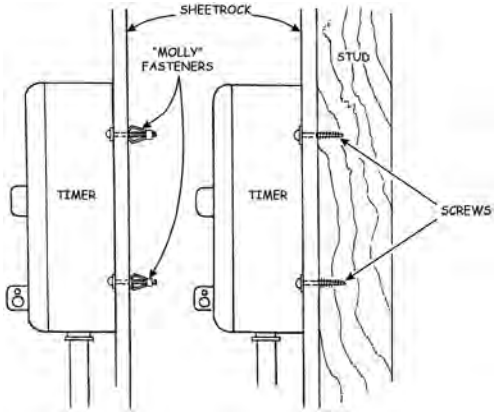


Fig. 16-1: Water Heater Timer Mounting

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

5.1.2 Electrical wiring shall conform with Housing and Community Development (HCD) and Housing and Urban Development (HUD) code requirements.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 There are no multi-family whole-building installation requirements. The conventional home (single-family) criteria apply to all multi-family whole-building installations.

6.1.3 Installation of an electric water heater timer on a common water heater (i.e., a system that serves multiple units) is not allowed.

6.1.4 Common area installation of an electric water heater timer (e.g., in a kitchen, laundry room, hallway, etc. within the same thermal boundary as the dwelling units) is not allowed when only an individual unit in a multi-family building will be served.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 The timer shall be checked to ensure proper operation.

8.1.2 The timer shall be set to accommodate the client's hot water requirements (minimum two setback cycles per day).

8.1.3 The water heater thermostat shall be set at 120°F or as prescribed by local code.

8.1.4 Installers shall allow for client comfort in programming the timer.

8.2. Client Education

8.2.1 Clients shall be educated on proper use and programming of the water heater timer, including potential danger when adjusting an outdoor timer in damp or wet conditions.

8.3. Clean-Up and Disposal Requirements

8.3.1 Packaging materials that include manufacturer's instructions or warranty information will be given to the customer.

8.3.2 All other installation and packaging materials shall be removed from the premises and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 4 years

9.1.2 DOE: Not applicable to this measure

9.2 All Water Heater Timers

9.2.1 Electrical Specification

9.2.1(a) The electrical circuit current capacity shall be greater than the maximum requirements of the water heater.

9.3 Timer Mechanism

9.3.1 The timer mechanism shall be:

9.3.1(a) Underwriters Laboratory (UL)-listed or equivalent

9.3.1(b) An electromechanical or digital timing mechanism

9.3.1(b1) An electromechanical timer should have captive trippers when feasible.

9.4 Outdoor Use

9.4.1 The timer shall be located in a National Electrical Manufacturers Association (NEMA) 3-, 4-, or 6-series weatherproof enclosure for outdoor use.

9.5 Programming Capability

9.5.1 The timer must have:

9.5.1(a) A manual override switch

9.5.1(b) Seven-day programmability

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

17. Faucet Aerators

Table of Contents

Faucet Aerators

1. MEASURE OBJECTIVES

1.1 Installation of an aerator reduces water and energy consumption by limiting the flow of water through the faucet.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 The faucet delivers heated water from the client's water heater and

2.2.2 The existing faucet/aerator maximum flow rates exceeds the following:

2.2.2(a) Kitchen: 1.8 gallons per minute (gpm), with optional temporary flow of 2.2 gpm at 60 lb. per sq. in. (psi)

2.2.2(b) Bath: 1.2 gpm at 60 psi

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The existing faucet is not operable or meets low-flow guidelines

3.2 The faucet or faucet threads are damaged, leaking, or incompatible with a standard size aerator

3.3 Removal of an existing aerator will cause damage to the aerator or faucet

3.4 The faucet has special fitting for attaching appliances (e.g., a portable dishwasher)

3.5 Installation would violate the Appendix E Health and Safety Requirements

3.6 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Water will be evaluated for debris that may clog the equipment.

4.1.2 Water flow that satisfies the occupant (without exceeding maximum flow rate) will be provided by all faucet aerators.

4.2. Installation Procedure

4.2.1 Close the sink drain to prevent loss of parts.

4.2.2 Prevent damage to the faucet finish (if using pliers).

4.2.3 Seal the threaded fitting with one layer of plumber's tape, when feasible.

4.2.3(a) Thread the new aerator onto the spout. Do not over-tighten.

4.2.3(b) Avoid cross-threading.

5. MOBILE HOME-SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 Common area installation (e.g., in a kitchen, laundry room, etc. within the same thermal boundary as the dwelling units) is allowed when justified by energy audit for a whole-building project, per Appendix D Energy Audit/Priority List Protocol.

6.1.3 (a) Common area installation is not allowed when only an individual unit in a multi-family building will be served.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 To assess for this measure as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.1 (a) The form will determine if the measure will be installed in the Audit path or the Priority List (PL) path.

7.1.1 (b) When assessing for this measure for the Audit path, this measure is a DOE Audit path, General Heat Waste (GHW) measure. The measures in this category include air filters, faucet aerators, low-flow showerheads, thermostatic showerheads, water heater blankets, and water heater pipe insulation.

7.1.1 (b1) When installing this measure as part of the Audit path work scope, a Measure SIR and Dwelling SIR are not required.

7.1.1 (b2) The maximum installed cost for all Audit path, GHW measures is $250.

7.1.1 (c) When assessing for the measure in the PL path, the feasibility will be based on building type and characteristics.

7.1.1 (c1) PL measures are classified as Mandatory or Optional based on building type.

- Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.
- Optional measures may be installed only after all feasible Mandatory PL measures have been installed.

7.1.1 (c2) This measure is a PL path Optional water measure. The measures in this category include faucet aerators, low-flow showerheads, thermostatic shower heads, water heater blankets, and water heater pipe insulation.

7.1.1 (c3) When installing this measure as part of the PL path work scope, a Measure SIR and Dwelling SIR are not required.

7.1.1 (c4) The maximum installed cost for all PL water measures is $250.

7.1.1 (d) When this measure is paid for by LIHEAP, or is cost-shared with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/Priority List Protocol.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP.

7.2.2 Single-Family

7.2.2 (a) None

7.2.3 Mobile Home

7.2.3 (a) Requirements for mobile homes are the same as those for single-family homes.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Operate the faucet to check for leaks and adequate water flow.

8.1.1(a) If a leak is present, tighten the aerator in small increments until the leaking stops. Do not over-tighten.

8.1.1(b) If necessary, replace or adjust the gasket washer and sealant tape.

8.2. Client Education

8.2.1 Both verbal and written instructions (which may include unit packaging) shall be provided regarding:

8.2.1(a) Proper operation and maintenance

8.2.1(b) How to remove, clean, and replace the aerator if the client's water quality is likely to cause the aerator to clog

8.2.1(c) Warranty

8.3. Clean-Up and Disposal Requirements

8.3.1 Packaging materials that include manufacturer's instructions or warranty information will be given to the customer.

8.3.2 All other installation and packaging materials shall be removed from the premises and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 4 years

9.1.2 DOE: Not applicable to this measure

9.2 Aerators shall:

9.2.1 Be metal (e.g., chrome-plated brass)

9.2.2 Conform to the American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME) A112.18.1 (2012)

9.2.3 Have a maximum flow rate of:

9.2.3(a) Kitchen: 1.8 gpm with optional temporary flow of 2.2 gpm at 60 psi

9.2.3(b) Bath: 1.2 gpm at 60 psi

10. WARRANTY

10.1 Manufacturer—3 years

10.2 Contractor—1 year

18. Low-Flow Showerheads

Table of Contents

Low-Flow Showerheads

1. MEASURE OBJECTIVES

1.1 Low-flow showerheads save water and energy compared to standard showerheads.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 The existing showerhead has a flow rate >1.8 gallons per minute (gpm)

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The client requires the existing showerhead for medical reasons

3.2 The existing shower arm is plastic, broken, missing, or corroded

3.3 A non-standard adapter would be required

3.4 The shower is not mechanically functional

3.5 There are broken/missing tiles or holes in the wall or surrounding surfaces (Fig. 18-1)

3.6 Visual inspection indicates the piping is in such poor condition that showerhead installation could cause water leaks or other plumbing problems

3.7 Installation would violate the Appendix E Health and Safety Requirements

3.8 The client refuses after measure benefits have been explained by the assessor

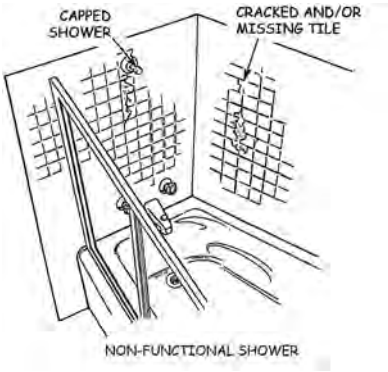


FIG. 18-1: FEATURES THAT PREVENT MEASURE INSTALLATION

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Handheld or standard showerheads may be installed.

4.1.2 Repair or replace the shower diverter, if needed.

4.1.3 When a thermostatic shower valve (TSV) will be installed at same time, refer to Section 19 Thermostatic Shower Valves and Showerheads.

4.1.4 Select features to meet any special needs of the occupant (e.g., shut-off, swivel, handheld showerhead).

4.1.5 If multiple heads are provided in a single shower, the total flow rate for all showerheads controlled by one valve should not exceed 1.8 gpm at 80 lb. per sq. in. (psi).

4.1.6 Water flow that satisfies the occupant (without exceeding maximum flow rate) will be provided by all showerheads.

4.2. Installation Procedure

4.2.1 Remove the existing showerhead.

4.2.2 Clean any debris that might clog the showerhead.

4.2.3 Clean the threads on the shower arm and seal them with plumber's tape.

4.2.4 The shower arm shall not be removed or replaced.

4.2.5 Thread the showerhead (and adapter, if needed) onto the arm (Fig. 18-2).

4.2.6 Handheld showerheads shall attach to the shower arm, not the wall.

FIG. 18-2: LOW-FLOW SHOWERHEAD

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 Common area installation (e.g., in a bathroom, utility room, etc. within the same thermal boundary as the dwelling units) is allowed when justified by energy audit for a whole-building project, per Appendix D Energy Audit/Priority List Protocol.

6.1.3(a) Common area installation is not allowed when only an individual unit in a multi-family building will be served.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 To assess for this measure as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.1(a) The form will determine if the measure will be installed in the Audit path or the Priority List (PL) path.

7.1.1(b) When assessing for this measure for the Audit path, this measure is a DOE Audit path, General Heat Waste (GHW) measure. The measures in this category include air filters, faucet aerators, low-flow showerheads, thermostatic showerheads, water heater insulation (blankets), and water heater pipe insulation.

7.1.1(b1) When installing this measure as part of the Audit path work scope, a Measure SIR and Dwelling SIR are not required.

7.1.1(b2) The maximum installed cost for all Audit path, GHW measures is $250.

7.1.1(c) When assessing for the measure in the PL path, the feasibility will be based on building type and characteristics.

7.1.1(c1) PL measures are classified as Mandatory or Optional based on building type.

- Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.
- Optional measures may be installed only after all feasible Mandatory PL measures have been installed.

7.1.1(c2) This measure is a PL path Optional water measure. The measures in this category include faucet aerators, low-flow showerheads, thermostatic shower heads, water heater blankets, and water heater pipe insulation.

7.1.1(c3) When installing this measure as part of the PL path work scope, a Measure SIR and Dwelling SIR are not required.

7.1.1(c4) The maximum installed cost for all PL water measures is $250.

7.1.1(d) When this measure is paid for by LIHEAP, or is cost-shared with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/Priority List Protocol.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP.

7.2.2 Single-Family

7.2.2(a) None

7.2.3 Mobile Home

7.2.3(a) Requirements for mobile homes are the same as those for single-family homes.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Operate the showerhead to check the connections for leaks and adequate water flow.

8.1.1(a) If a leak is present, tighten the showerhead in small increments until the leaking stops. Do not over-tighten.

8.1.1(b) If necessary, replace or adjust the gasket washer and sealant tape.

8.2. Client Education

8.2.1 The client shall be supplied with:

8.2.1(a) Instructions for proper operation and maintenance

8.2.1(b) Warranty

8.3. Clean-Up and Disposal Requirements

8.3.1 Replaced showerheads, parts, and packaging shall be removed from the property and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 4 years

9.1.2 DOE: 15 years

9.2 All showerheads shall:

9.2.1 Be the pressure-compensating type for consistent performance (i.e., to maintain a constant temperature under varying pressures)

9.2.2 Have a maximum flow rate of 1.8 gpm at 80 psi

9.3 Wall-mount showerheads shall:

9.3.1 Be the “self-cleaning” type or able to be cleaned without being unscrewed from the shower arm

9.3.2 Be the non-aerating type

9.3.3 Have a metal ball joint (e.g., chrome-plated brass)

9.4 Handheld showerheads

9.4.1 Hose: Minimum 48" length, capable of swiveling at both ends, and constructed of reinforced (e.g., with nylon) flexible vinyl or polyvinylchloride (PVC) material

9.4.2 Mounting bracket: Designed to attach to the shower arm (not the wall) and constructed of heavy-duty thermoplastic (e.g., acrylonitrile-butadiene-styrene [ABS]) or equivalent with an all-metal swivel ball (e.g., chrome-plated brass)

9.4.3 Attachment: Fit standard-thread shower arms and standard adapters

9.4.4 Anti-siphon valve

9.5 Showerarm adapters shall:

9.5.1 Be metal (e.g., chrome-plated brass)

9.5.2 Have a ½" national pipe taper (NPT) fitting on the showerhead end

10. WARRANTY

10.1 Manufacturer—3 years

10.2 Contractor—1 year

19. Thermostatic Shower Valves and Showerheads

Table of Contents

Thermostatic Shower Valves and Showerheads

1. MEASURE OBJECTIVES

1.1 Thermostatic shower valves (TSVs) and thermostatic showerheads save water and energy by reducing shower flow to a trickle after a set temperature level is reached.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 The shower is functional and the measure is not already installed

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 Visual inspection indicates that the piping is in such poor condition that installation of a TSV or a thermostatic showerhead could damage the plumbing

3.2 The existing shower arm:

3.2.1 Is made of plastic (including ball joint)

3.2.2 Is cracked, broken, or missing

3.2.3 Requires removal or replacement

3.2.4 Requires an adapter, and standard metal adapters will not work

3.3 Hot water is provided by an on-demand (tankless) water heater or circulating pump

3.4 Installation would violate the Appendix E Health and Safety Requirements

3.5 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Thermostatic component options are:

4.1.1(a) TSV only (Fig. 19-1)

4.1.1(b) Thermostatic showerhead (Fig. 19-2)

4.1.2 If the existing showerhead output is ≤1.8 gallons per minute (gpm), the addition of only a TSV is allowed.

4.1.3 When the existing showerhead output is >1.8 gpm, it must be replaced with a thermostatic showerhead.

4.1.3(a) A shower arm adapter shall be installed when required for installation of the thermostatic showerhead.

Photo Credit: Evolve Technologies LLC

FIG. 19-1: THERMOSTATIC SHOWER VALVE (TSV)

Photo Credit: Evolve Technologoes LLC

FIG. 19-2: THERMOSTATIC SHOWERHEAD

4.2. Installation Procedure

4.2.1 Remove the existing showerhead.

4.2.2 Clean any debris that clogs the showerhead.

4.2.3 The shower arm shall not be removed or replaced.

4.2.4 Clean the threads on the shower arm and seal them with plumber's tape.

4.2.5 Thread the TSV/showerhead (and adapter, if needed) onto the arm (Fig. 19-3) and tighten it.

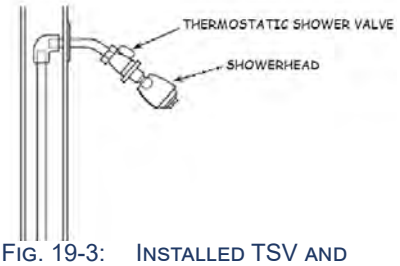


FIG. 19-3: INSTALLED TSV AND SHOWERHEAD

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 Common area installation (e.g., in a lobby bathroom, utility room, etc. within the same thermal boundary as the dwelling units) is allowed when justified by energy audit for a whole-building project, per Appendix D Energy Audit/Priority List Protocol.

6.1.3(a) Common area installation is not allowed when only an individual unit in a multi-family building will be served.

7. DOE–SPECIFIC

7.1. Assessment Requirements

7.1.1 Thermostatic Shower Valve

7.1.1(a) This is not a DOE measure.

7.1.2 Thermostatic Showerhead

7.1.2(a) To assess for this measure as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.2(a1) The form will determine if the measure will be installed in the Audit path or the Priority List (PL) path.

7.1.2(a2) When assessing for this measure for the Audit path, this measure is a DOE Audit path, General Heat Waste (GHW) measure. The measures in this category include air filters, faucet aerators, low-flow showerheads, thermostatic showerheads, water heater insulation (blankets), and water heater pipe insulation.

- When installing this measure as part of the Audit path work scope, a Measure SIR and Dwelling SIR are not required.
- The maximum installed cost for all Audit path, GHW measures is $250.

7.1.2(a3) When assessing for the measure in the PL path, the feasibility will be based on building type and characteristics.

- PL measures are classified as Mandatory or Optional based on building type.
  - Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.
  - Optional measures may be installed only after all feasible Mandatory PL measures have been installed.
- This measure is a PL path Optional water measure. The measures in this category include faucet aerators, low-flow showerheads, thermostatic shower heads, water heater blankets, and water heater pipe insulation.
- When installing this measure as part of the PL path work scope, a Measure SIR and Dwelling SIR are not required.

- The maximum installed cost for all PL water measures is $250.

7.1.2(b) When this measure is paid for by LIHEAP, or is cost-shared with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/Priority List Protocol.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE (for thermostatic showerheads) are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2(a) None

7.2.3 Mobile Home

7.2.3(a) Requirements for mobile homes are the same as those for single-family homes.

7.2.4 Multi-Family

7.2.4(a) Excerpted from 2107 SWS 7.8101.2:

7.2.4(a1) Showerheads with shut-off valves will not be installed in multi-family buildings with central water heating systems.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Operate the shower to confirm that:

8.1.1(a) Water flow reduces to a trickle when the water heats up beyond the set level

8.1.1(b) Water flow is reactivated with the manual control

8.1.1(c) Connections do not leak

8.2. Client Education

8.2.1 The client shall be supplied with both verbal and written instructions for:

8.2.1(a) Proper operation and maintenance

8.2.1(b) Safety considerations

8.2.1(c) Warranty

8.2.2 Occupants receiving a TSV or thermostatic showerhead shall be educated regarding the risk of sudden water temperature changes.

8.2.2(a) Sudden temperature changes are more prevalent in older homes with undersized piping and no temperature-compensating shower valve.

8.2.2(b) Education shall include explanation of the following:

8.2.2(b1) The TSV or thermostatic showerhead will not protect against scalding.

8.2.2(b2) Use of a nearby cold water fixture (e.g., toilet or faucet) can cause a sudden increase in water temperature in the shower (possible scalding).

8.2.2(b3) Use of hot water elsewhere in the home (e.g., clothes washer, dishwasher, hot water faucet, etc.) can cause a sudden decrease in water temperature in the shower.

8.2.2(b4) To save energy and decrease the chance of scalding, the water heater thermostat should be set no higher than 120ºF.

8.3. Clean-Up and Disposal Requirements

8.3.1 Replaced showerheads, parts, and packaging shall be removed from the property and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: TSV/thermostatic showerhead—10 years

9.1.2 DOE:

9.1.2(a) TSV—Not applicable to this measure

9.1.2(b) Thermostatic showerhead—15 years

9.2 All TSVs and thermostatic showerheads shall be:

9.2.1 Compliant with International Association of Plumbing and Mechanical Officials Guide Criteria (IAPMO IGC) 244-2015A

9.2.2 Threaded to attach to showerheads and shower arms with ½" national pipe taper (NPT) fittings.

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

20. High-Efficiency Toilets

Table of Contents

High-Efficiency Toilets

1. MEASURE OBJECTIVE

1.1 A high-efficiency toilet reduces water and wastewater costs in comparison to a less efficient toilet.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 Required by the local jurisdiction as a condition of final permit and

2.2.2 The existing toilet has a flush volume greater than the criteria set by the local jurisdiction

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The flush volume of the existing toilet is ≤ 1.6 gallons per flush (gpf)

3.2 The home was built and available for occupancy on or after January 2, 1994

3.3 The home is a registered historic site

3.4 There is inadequate anchor bolt distance from the rear wall (rough-in)

3.5 There is inadequate clearance on the sides of the toilet, above the tank, or to the front of the toilet

3.6 There is significant floor damage that cannot be corrected within this measure

3.7 There is water leakage, corrosion, or a malfunction at the water shut-off valve that cannot be corrected by valve replacement

3.8 Installation would violate the Appendix E Health and Safety Requirements

3.9 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Permit

4.1.1(a) If the local jurisdiction requires a permit for toilet replacement, one shall be obtained and finalized.

4.1.1(b) When a permit for a separate weatherization measure requires toilet replacement, client refusal of the replacement may make the other measure not feasible by association.

4.1.2 Procedure to Estimate Flush Volume

4.1.2(a) Estimate the flush volume of existing toilets using one of the following information sources:

4.1.2(a1) The gpf written on the bowl rim (newer, low-volume toilets)

4.1.2(a2) The manufacture date (vintage) or gpf stamped inside the tank or on the underside of the lid (older units)

- When the manufacturing date is available, see Table 20-1 to determine flush volume.

4.1.2(a3) Pressure-assist toilets can be assumed have a flush volume of 1.6 gpf or less.

Table 20-1: Typical Flush Volume for Toilet Vintage

Toilet Vintage	Typical Flush Volume
Before 1985	5–7 gpf
Between 1985–1989	3.5 gpf
Between 1990–1993	3.5–1.6 gpf It is required to determine the flush volume.
Between 1994–2013	1.6 gpf Toilet does not qualify for replacement.
After January 1, 2014	1.28 gpf Toilet does not qualify for replacement.

4.1.2(b) If the toilet's label is written in liters, convert to gallons using this equation:

Liters x 0.2642 = Gallons

4.1.2(b1) If it is not possible to determine the flush volume from the labeling or vintage, use the Procedure to Measure Flush Volume.

4.1.3 Procedure to Measure Flush Volume

4.1.3(a) Remove any water-saving devices in the tank and allow the tank to fill completely.

4.1.3(b) Turn off the water supply.

4.1.3(c) Use a pencil to mark the water level inside the tank.

4.1.3(d) Flush the toilet.

4.1.3(e) Use a calibrated measuring container to fill the tank to the pencil line.

4.1.3(f) Record the volume of water used to fill the tank (gpf).

4.1.3(g) Turn on the water supply to return the toilet to normal operation.

4.1.3(h) Ensure the toilet flushes and refills properly, the water stops running into the tank and bowl, and the flapper is seated properly.

4.2. Installation Procedure

4.2.1 Toilet Removal and Preparation

4.2.1(a) Remove the toilet.

4.2.1(b) Remove the existing anchor bolts.

4.2.1(c) The toilet flange and the floor area under the toilet shall be cleaned and checked for damage.

4.2.1(d) A flange extension may be used if the toilet flange is too low (per the toilet manufacturer's specification, typically ¼" above the floor).

4.2.2 Floor Repair

4.2.2(a) When the toilet is unstable due to a damaged/degraded floor, repairs to the floor must be made before the new toilet is installed.

4.2.2(b) Replace damaged wood flooring material and weakened framing members.

4.2.2(b1) Secure wooden materials with corrosion-resistant anchors.

4.2.2(c) Install floor covering (e.g., vinyl) as needed to facilitate installation of new toilet.

4.2.2(c1) Ensure the level of the replacement material matches the existing floor level.

4.2.3 Flange Replacement

4.2.3(a) Replace the toilet flange (Fig. 20-1) if it is damaged.

4.2.3(b) When the waste pipe is cast iron:

4.2.3(b1) Remove the existing flange and replace it with plastic parts

4.2.3(b2) Care must be taken to not damage or break the cast iron pipe

4.2.3(c) When the toilet flange is secured by screws, they must penetrate solid material.

4.2.3(d) Install a flange extension when needed to raise the toilet flange to the required height.

Fig. 20-1: Toilet Flange

4.2.4 Toilet Installation

4.2.4(a) Set the toilet over the bolts, pressing the wax ring firmly into place over the toilet flange.

4.2.4(b) Ensure the toilet sits flat on the floor, is level, and does not rock.

4.2.4(b1) Install toilet shims as needed.

4.2.4(b2) Trim shims at the edge of the toilet.

4.2.4(c) Trim long toilet anchor bolts to allow for cap installation.

4.2.4(d) Use manufacturer-supplied installation hardware.

4.2.5 Tank Installation

4.2.5(a) With the tank-to-bowl spud washer in place, hand-tighten the tank bolts evenly, then tighten them slightly with a wrench.

4.2.5(b) If there is a leak when the tank is filled with water, tighten the bolts enough to stop the leak. (Avoid over-tightening.)

4.2.6 Water Shut-Off Valve

4.2.6(a) When the existing valve is defective or leaking, install a new water shut-off valve.

4.2.6(b) Apply pipe joint compound or plumber's tape to the threaded nipple.

4.2.6(c) Tighten the valve onto the threads and test for leaks.

4.2.7 Water Supply Line

4.2.7(a) Install a new, braided, flexible toilet tank supply line of the proper length in accordance with the manufacturer's instructions.

4.2.8 Final Installation Procedures

4.2.8(a) Fasten the toilet seat in a centered position.

4.2.8(b) Secure toilet to flange with a new gasket.

4.2.8(c) Flush toilet to make sure there are no leaks between the flange and the toilet.

4.2.8(d) Apply a consistent bead of caulk to form a watertight seal between the toilet and the floor (Fig. 20-2).

4.2.8(d1) Caulk shall neatly and completely cover shims when they are present.

Fig. 20-2: Sealant Bead Applied Around the Entire Base of the Toilet

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

5.1.2 Carefully inspect the waste line if it is older plastic piping (e.g., polybutylene).

5.1.3 Polybutylene pipe (gray tubing made between the late 1970s–mid-1990s) can be fragile and subject to leaking. It must be evaluated by an experienced plumber to determine if toilet replacement is feasible.

5.1.4 When the existing piping can safely be used, a transition shall be installed as needed to properly join the new pipe to the old plastic pipe.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 There are no multi-family whole-building installation requirements. The conventional home (single-family) criteria apply to all multi-family whole-building installations.

6.1.3 When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.3(a) Common area installation (e.g., in a lobby, entertainment room, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 The tank shall be filled and flushed at least two times.

8.1.2 All joints shall be checked for water leaks and tightened as needed for a proper seal.

8.1.3 The toilet shall be level, solid, and secure.

8.2. Client Education

8.2.1 Both verbal and written instructions shall be provided regarding:

8.2.1(a) Operation, care, and cleaning of the toilet

8.2.1(b) Acquisition of replacement parts

8.2.1(c) Warranty

8.2.2 The contractor's and toilet manufacturer's warranty documentation shall be given to the customer.

8.3. Clean-up and Disposal Requirements

8.3.1 All parts and debris associated with the toilet replacement shall be removed from the premises, and the work site shall be left clean.

8.3.2 The removed toilet shall be disposed of (recycled when possible) in accordance with local requirements.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 20 years

9.1.2 DOE: Not applicable to this measure

9.2 Accessories

9.2.1 Water Shut-Off Valve (Angle Stop) and Supply Line

9.2.1(a) The water supply line shall be braided hose with brass fittings.

9.2.1(b) The water shut-off valve shall comply with International Association of Plumbing and Mechanical Officials (IAPMO) and California Plumbing Code (CPC) requirements.

9.2.2 Wax Ring with Flange

9.2.2(a) The ring shall be thick or reinforced wax with a polyethylene flange that complies with Federal Specification (FS) TT-P-1536A.

9.2.2(a1) A flange is not required when a second ring is placed on top of the first for additional thickness.

9.2.3 Replacement Toilet Anchor Bolts ("Johnny Bolts"), Washers, and Nuts

9.2.3(a) Replacement hardware shall be:

9.2.3(a1) Brass bolts:, 2¼" length by 5⁄16" diameter minimum, with captive corrosion-resistant (e.g., stainless steel) washers included to secure the flange bolt in an upright position

9.2.3(a2) Brass open-cap acorn nuts

9.2.4 Toilet bolt caps shall be plastic or ceramic, color-matched to the toilet.

9.2.5 Replacement plastic toilet flanges and toilet flange extensions and spacers shall comply with American Society of Mechanical Engineers (ASME) A112.4.3.

9.2.6 Toilet shims shall be:

9.2.6(a) White plastic or other waterproof material for use with toilets

9.2.6(b) Snap-off shims or shims that are easy to trim with a sharp knife

9.3 Toilets shall:

9.3.1 Be WaterSense-labeled

9.3.2 Be single-flush rated 1.28 gpf or less

9.3.3 Have a maximum performance rating of ≥350 grams

9.3.4 Have a fully glazed, 2" minimum trapway

9.3.5 Have an elongated or round bowl per availability, client preference, and location dimensions and clearances

9.3.6 Have a minimum 15" bowl height (excluding seat) for a standard toilet

9.3.6(a) When Americans with Disabilities Act (ADA) compliance is required, the vertical distance from the finished floor to the top of the seat shall be a minimum 15" and maximum 19".

9.3.6(b) Unit height shall be selected in accordance with the client's physical needs and wishes.

9.4 Flooring Material

9.4.1 Plywood shall be exterior-grade, pressure-treated, or marine-grade material.

9.4.2 Replacement flooring shall match the height of the surrounding floor material.

9.4.3 Additional support to joists shall be installed when needed to make the floor solid.

9.5 Caulk (to seal between the toilet base and the floor) shall:

9.5.1 Be mold-resistant acrylic latex or equivalent

9.5.2 Comply with American Society of Testing and Materials (ASTM) C834, C920, or C1311

9.6 The toilet seat shall be thermoplastic (e.g., polypropylene injection molded plastic) or thermoset (e.g., Thermodur® or Duroplast®).

10. WARRANTY

10.1 Manufacturer—3 years

10.2 Contractor—1 year

21. Cooktops, Ovens, and Ranges

Table of Contents

Cooktops, Ovens, and Ranges

1. MEASURE OBJECTIVES

1.1 A properly functioning gas or electric cooking appliance provides safe cooking, energy efficiency, and convenience.

1.1.1 Cooktop: Built into a countertop

1.1.2 Oven: Built into a wall

1.1.3 Range: Freestanding or slide-in combination of cooktop and oven

2. INSTALL THIS MEASURE WHEN:

2.1. Repair/Install

2.1.1 A cooktop, oven, or range is causing a combustion appliance safety (CAS) hazard per Appendix A Combustion Appliance Safety Protocol or is creating an electrical or gas hazard

2.2. Repair

2.2.1 A gas range oven will not stay lit and cannot be tested

2.2.2 One or more burners can be repaired

2.3. Install

2.3.1 Repair costs would exceed 50% of replacement costs or

2.3.2 Repair parts are obsolete (not available)

2.3.3 Repair is not feasible

2.3.4 Three or more burners are inoperable and one or more burners cannot be repaired

2.3.5 An oven door does not close properly because it is sprung or damaged

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1. Do Not Repair/Install

3.1.1 The existing cooking appliance operates safely

3.1.2 The appliance is not the dwelling's primary cooking appliance

3.1.3 At least two cooktop or range burners are operable and no hazard is present

3.1.4 Installation would violate the Appendix E Health and Safety Requirements

3.1.5 The client refuses after measure benefits have been explained by the assessor

3.2. Do Not Install

3.2.1 The oven in a range is inoperable but the cooktop burners work and there is no carbon monoxide (CO) hazard

3.2.2 The available location is not acceptable (e.g., there are inadequate clearances or access, or the floor/wall/cabinet will not withstand the weight)

3.2.3 An existing kitchen exhaust is present and is not operating properly or does not meet clearance requirements and cannot be corrected per Section 11 Kitchen Exhaust

3.2.4 The electrical or gas supply is inaccessible or is substandard, and correction is beyond the scope of the program

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 For gas appliances, CAS testing must be performed before any repair or replacement activities. See Appendix A Combustion Appliance Safety Protocol.

4.1.2 Beyond Program Scope Documentation

4.1.2(a) When repair or replacement of the cooking appliance is beyond the program scope:

4.1.2(a1) Detailed documentation of the reason is required

4.1.2(a2) The client will be offered the opportunity to abandon the appliance

4.1.2(a3) If the client does not have a microwave oven to use as an alternative cooking appliance, one shall be offered. (See Section 22 Microwave Ovens.)

4.1.3 Client Advisory Conditions

4.1.3(a) If a gas leak is not present and CO levels are within acceptable limits, the following are considered client advisory conditions per Appendix A Combustion Appliance Safety Protocol. Such conditions do not require correction and do not prevent duct and shell sealing or other infiltration reduction measures:

4.1.3(a1) The pilot does not work, but the burner(s) can be lit with a match or lighter.

4.1.3(a2) A burner knob/valve is frozen, or a burner will not light for some other reason (including with a match or lighter).

4.1.3(a3) Up to two cooktop burners or the oven/broiler burner are non-operational.

4.1.4 Do not install a new appliance with damage or defects.

4.1.5 Fuel Switching

4.1.5(a) Fuel switching requires waiver approval in advance by CSD.

4.1.5(a1) The appliance shall be verified to be compatible with the fuel used (i.e., natural gas or liquid propane.

4.1.5(b) Conversion kits must be supplied/specified by the cooking appliance manufacturer.

4.1.6 Installation Location

4.1.6(a) The floor or support surface must be stable, solid, level, and capable of properly supporting the cooking appliance.

4.1.6(a1) Bracing shall be installed when the installation location does not have a solid floor or support surface to safely support the weight of the cooking appliance.

4.1.6(a2) Cooking appliance support or base surface material shall meet the temperature (minimum 194°F) and strength requirements specified by the cooking appliance manufacturer.

4.1.6(b) The floor covering will not be carpet unless it is allowed by the manufacturer.

4.1.6(c) For gas appliances, openings in the base of a cooking appliance that supply combustion ventilation air to the unit must not be obstructed.

4.1.6(d) Location shall provide ample room to fully open the oven door without being obstructed by surrounding cabinets or appliances.

4.1.7 Clearance Requirements for Cooktops and Ranges

4.1.7(a) Horizontal and vertical clearances will be as specified by the appliance manufacturer, or by local code if more stringent.

4.1.7(b) If not specified, the following minimum guidelines apply (Fig. 21-1):

4.1.7(b1) Minimum 30" of vertical clearance between the cooking surface and overhead combustible material or metal cabinets

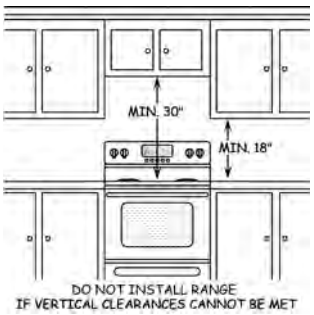


FIG. 21-1: CLEARANCE REQUIREMENTS

4.1.7(b2) Minimum 24" vertical clearance between the cooking surface and an overhead ventilating hood or sheet metal–clad insulating board

4.1.7(b3) Minimum 18" vertical clearance between the cooking surface and cabinets located within 6" on either side of the range

4.1.7(c) If vertical clearance to unprotected cabinets above the unit is less than 30" and a protective shield or kitchen exhaust is not present at least 24" above the cooktop, then:

4.1.7(c1) A code-compliant protective shield will be installed or

4.1.7(c2) A qualifying kitchen exhaust will be installed with an approved CSD waiver (see Section 11 Kitchen Exhaust) or

4.1.7(c3) Cooking appliance replacement is not possible and will not be attempted

4.1.7(d) If a listed microwave oven is located above the cooking appliance, vertical clearance from it to the cooktop will comply with the microwave oven listing and manufacturer's instructions.

4.1.7(e) If a kitchen exhaust is present, clearance may be reduced if the manufacturer's instructions specify reduced vertical clearance to the exhaust fan.

4.1.7(f) If modifications are necessary to adjust clearances to meet requirements, the feasibility of such modification will be verified prior to installation of the new cooking appliance.

4.1.8 Clearance Requirements for Built-in Ovens

4.1.8(a) Horizontal and vertical clearances must comply with the appliance manufacturer and local code if more stringent.

4.1.8(b) Manufacturer supplied pedestal or trim kit shall be installed when required to meet the manufacturer specified height and width clearances.

4.1.8(c) The cabinet cutout shall be deep enough to fit the oven.

4.1.8(c1) Trim on the face of the oven shall sit flush against the cabinet.

4.1.8(c2) Wiring and/or gas connectors shall not be kinked or pinched between the back of the cabinet and the oven.

4.2. Installation Procedure

4.2.1 Electrical Circuit

4.2.1(a) Verify that the existing electrical circuit conforms—or can be made to conform—with the manufacturer's instructions and local code. (See Section 1 General Installation Guidelines, Electrical Guidelines.)

4.2.1(b) All electrical alterations shall be performed by a qualified technician.

4.2.2 Receptacle

4.2.2(a) 120-volt receptacle

4.2.2(a1) The outlet must be properly grounded if required by the manufacturer.

4.2.2(a2) If installing a new receptacle, see Section 1 General Installation Guidelines, Electrical Guidelines.

- The receptacle may be oriented upside-down (with the ground slot positioned upward) if the power cord has a right-angle plug with the ground prong positioned at the top (Fig. 21-2).

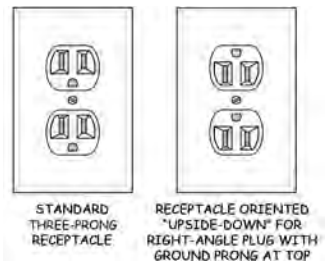


FIG. 21-2: ELECTRIC RECEPTACLE UPSIDE DOWN

4.2.2(a3) Ground fault circuit interrupter (GFCI) option

- See Section 1 General Installation Guidelines, Electrical Guidelines.

4.2.2(b) 240-volt receptacle

4.2.2(b1) For electric appliances, a 240-volt receptacle (e.g., National Electrical Manufacturers Association [NEMA]–type 14-50R four-wire or 10-50R three-wire) is required (Fig. 21-3).

4.2.2(b2) Power supply cord (pigtail) or direct wire cable and strain relief (Fig. 21-4):

- If not factory-installed, attach the conductors to the cooking appliance main terminal block per manufacturer's instructions using the appropriate diameter hole in the mounting plate.
- Pull excess wire out of appliance compartment and install strain relief as instructed on the pigtail or "direct-wire" conduit.

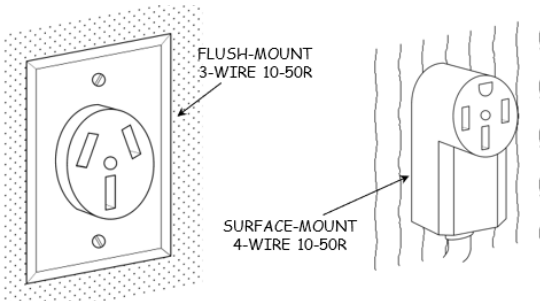


FIG. 21-3: COOKSTOVE ELECTRIC RECEPTACLES

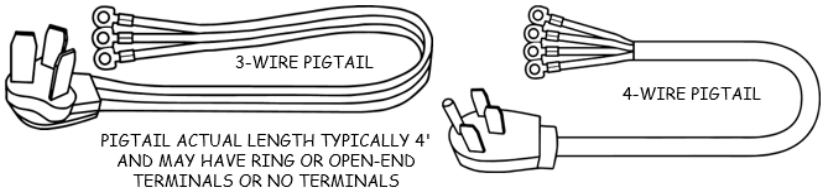


FIG. 21-4: POWER SUPPLY PIGTAILS FOR ELECTRIC COOKING APPLIANCES

- If converting from a three-wire to a four-wire (or vice versa), follow the manufacturer's instructions for connection to the stove.

4.2.2(c) Plug the appliance power cord directly into the receptacle. Do not connect a three-prong adapter or extension cord to the receptacle.

4.2.2(d) Do not plug the appliance power cord into a receptacle that is not properly secured or has an electrical hazard.

4.2.3 Gas Pre-Check

4.2.3(a) Gas leaks

4.2.3(a1) Prior to removal of the existing cooking appliance, check the gas piping for leaks using the procedures prescribed in Appendix A Combustion Appliance Safety Protocol.

4.2.3(b) Pressure

4.2.3(b1) Gas pressure in the gas line serving the cooking appliance must be within the limits prescribed by the manufacturer.

4.2.3(b2) The gas supply line must have a pressure regulator.

4.2.3(b3) When a cooking appliance is replaced and the flame's appearance is over- or undersized, the pressure will be checked by a qualified technician.

4.2.3(c) Gas shut-off valve

4.2.3(c1) Install a new gas shut-off valve and connection components.

- See instructions in Section 1 General Installation Guidelines, Appliance Repair/Replacement.

4.2.4 Anti-Tip/Tilt Device for a Range

4.2.4(a) When required by manufacturer, install an anti-tip device according to the manufacturer's instructions.

4.2.4(b) Verify proper installation by carefully attempting to tilt the range forward.

4.2.5 Positioning

4.2.5(a) Place the cooking appliance in its final position.

4.2.5(b) Guide the flexible gas line and power cord into a safe position with no kinks.

4.2.5(c) Check that the appliance is level using a spirit level placed diagonally on an oven shelf.

4.2.5(d) Adjust the leveling screws per the manufacturer's instructions until the appliance is level side-to-side and front-to-back.

4.2.5(e) Do not seal the cooking appliance to the side cabinets (e.g., with caulk).

5. MOBILE HOME-SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

5.1.2 Replacement will comply with standards specified by Housing and Community Development (HCD).

5.1.3 For electric appliances, the installed receptacle shall be a grounded four-wire type (e.g., NEMA 4-50R) if a four-wire circuit is present or required by HCD.

5.1.4 Minimum 24" of vertical clearance is required from the cooktop to the bottom of combustible cabinets.

5.1.5 The range will be secured to the floor when required by HCD regulations or manufacturer's instructions.

5.1.6 Gas Cooking Appliances

5.1.6(a) One of the following must be located within 10' of the replacement gas cooking appliance and must be vented outdoors:

5.1.6(a1) An operable exhaust fan (Fig. 21-5) with manual or automatic damper or

5.1.6(a2) A metal duct located above the cooktop with a cross-sectional area of at least 12.5 sq. in. and a minimum dimension of 2".

- If a range hood must be repaired or installed to meet these requirements, it shall comply with Section 11 Kitchen Exhaust.

5.1.6(b) If required ventilation is not present in the mobile home and cannot be provided, the home is eligible for non-infiltration measures only (the home is NIM) and a replacement gas cookstove shall not be installed.

FIG. 21-5: FAN OR PASSIVE VENT REQUIRED IN MOBILE HOME COOKING AREA

6. MULTI-FAMILY-SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 There are no multi-family whole-building installation requirements. The conventional home (single-family) criteria apply to all multi-family whole-building installations

6.1.3 When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.3(a) Common area installation (e.g., in a shared kitchen, entertainment room, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

7.1.2 If the unit is identified as having operational issues that create an unsafe environment, the unit shall be repaired or replaced using alternative funding.

7.1.2(a) If alternative funding is not available, the appliance shall be removed with written client permission, or the condition requires home deferral.

7.1.2(b) The condition shall be documented on the CSD 542 Weatherization Deferral Form if alternative funding is not used to correct the condition.

7.1.3 Mobile Home Combustion Appliances

7.1.3(a) All cooking appliances left in place after weatherization in mobile homes must meet the Manufactured Home Construction and Safety Standards.

7.1.3(a1) If a client will not allow removal of an unsafe cooking appliance from the home, and repair or replacement is not feasible under LIHEAP, deferral is required.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Follow the manufacturer's start-up/test procedures to ensure proper operation of the cooktop and oven.

8.1.2 Verify that each new or repaired cooktop or range and oven burner operates properly.

8.1.3 After air is purged from the line, verify that the gas cooktop and oven burners light and burn properly over the full range (high to low).

8.1.4 Verify that the clock, timer, and electronic controls operate properly.

8.1.5 Perform troubleshooting per the manufacturer's instructions as needed to correct problems.

8.1.6 Perform post-CAS appliance repair/replacement testing for CO in accordance with the Appendix A Combustion Appliance Safety Protocol.

8.2. Client Education

8.2.1 Give the client verbal instructions and demonstrate features and operation of the cooking appliance, including the troubleshooting guide in the owner's manual.

8.2.1(a) If the range has a battery igniter, advise the client on replacing the battery.

8.2.2 Show the client the location of the gas shut-off valve, electrical shut-off, and GFCI (if installed).

8.2.3 The client shall be informed of the importance of using exhaust ventilation when cooking and of the importance of keeping burners and broilers clean to limit the production of CO.

8.3. Clean-Up and Disposal Requirement

8.3.1 Follow the manufacturer's cleaning recommendations.

8.3.2 Remove from the appliance any marks and residue left by protective shipping material and smudges that occurred during shipping and installation.

8.3.3 Clean the cabinet, oven, cooktop, and controls.

8.3.4 Remove all replaced appliances and parts from the property and dispose of them properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP:

9.1.1(a) Repair—4 years

9.1.1(b) Install—10 years

9.1.2 DOE: Not applicable to this measure

9.2 Gas Components

9.2.1 Replacement gas ranges must:

9.2.1(a) Be Canadian Standards Association (CSA)–certified, Underwriters Laboratories (UL)–listed, or equivalent

9.2.1(b) Comply with American National Standards Institute (ANSI) Z21.1

9.2.1(c) Have electronic ignition (shall not have standing pilots)

9.2.1(c1) Ranges with battery ignition are allowed.

9.2.1(c2) The range must be compatible with the fuel used (i.e., natural gas, liquid petroleum or electric).

9.2.1(d) Have sealed or standard burners

9.2.1(e) Have a standard oven

9.2.1(e1) Ranges with self-cleaning ovens are allowed.

9.2.2 Replacement gas cooktops require electronic ignition unless it is not possible to provide a 110-volt alternating current circuit to the cooktop location.

9.2.3 Gas shut-off valves and adapters will be new, brass, and CSA- or American Gas Association (AGA)–approved.

9.2.4 The flexible gas connector will be:

9.2.4(a) New coated or uncoated stainless steel up to 6' in length

9.2.4(b) Compliant with ANSI Z21.24/CSA 6.10 or AGA-approved

9.3 Electrical components supplied by the installer shall meet NEMA standards and be UL-listed or equivalent (e.g., power supply cord, circuit breaker or fuse, and receptacle).

9.3.1 The receptacle shall match the plug on the appliance power cord (pigtail) (e.g., NEMA type 14-50R four-wire or 10-50R three-wire 240-volt receptacle) and be approved by the manufacturer.

9.3.2 Replacement electric range or cooktops shall be:

9.3.2(a) UL-listed or equivalent

9.3.2(b) Compliant with local code

9.3.2(c) Sealed or standard design burners, with a standard oven

9.3.2(c1) Glass-top and self-cleaning models are allowed.

9.4 Replacement gas wall ovens shall be:

9.4.1 CSA-certified, UL-listed, or equivalent

9.4.2 Compliant with ANSI Z21.1

9.4.3 Equipped with electronic ignitions (shall not have standing pilot)

9.4.4 Single- or double-wall configuration, and may feature a self-cleaning mode

9.4.5 Approved for use in the planned installation location

9.4.5(a) Units to be installed undercounter must be labeled for undercounter installation.

9.5 Replacement electric wall ovens shall be:

9.5.1 UL-listed or equivalent

9.5.2 Compliant with local code

9.5.3 Single- or double-wall configuration, and may feature a self-cleaning mode

9.5.4 Approved for use in the planned installation location

9.5.4(a) Units to be installed undercounter must be labeled for undercounter installation.

10. WARRANTY

Repair

10.1 Manufacturer—90 days

10.2 Contractor—1 year

Install

10.3 Manufacturer—1 year

10.4 Contractor—1 year

22. Microwave Ovens

Table of Contents

Microwave Ovens

1. MEASURE OBJECTIVE

1.1 A microwave oven saves energy when used in place of a conventional cooking appliance.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure

2.2. Install

2.2.1 No existing microwave oven is present

2.2.2 The existing microwave oven is inoperable or poses an electrical hazard

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 An appropriate location is not available

3.2 No acceptable electrical outlet is available, or the existing outlet is unsecured

3.3 An existing electrical hazard is present and is not correctable within the program scope

3.4 Installation would violate the Appendix E Health and Safety Requirements

3.5 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 The microwave oven shall be plugged into its own receptacle when feasible.

4.1.2 A broken or missing outlet cover plate shall be replaced before the measure is installed.

4.2. Installation Procedure

4.2.1 Installation shall not damage the counter or tabletop covering or interior finishes.

4.2.2 Location

4.2.2(a) The counter or tabletop shall be structurally adequate to safely support the microwave oven.

4.2.2(b) Clearances shall meet the manufacturer's specifications.

4.2.3 The microwave shall be installed in a level, plumb, and stable position, with leveling devices on the microwave oven adjusted accordingly.

4.2.4 Electrical Requirements

4.2.4(a) The microwave oven shall be connected to a grounded outlet per Section 1 General Installation Guidelines, Grounding Guidelines.

4.2.4(b) Ground-fault circuit interrupter (GFCI)

4.2.4(b1) A GFCI-protected receptacle may be used instead of a grounded three-prong receptacle, but only if acceptable to the occupants.

- The location for resetting the GFCI must be easily accessible.
- Advise occupants of the possibility of nuisance tripping.
- Instruct occupants in the use and resetting of the GFCI circuit.

4.2.4(c) Three-prong adapter

4.2.4(c1) Three-prong adapters (Fig. 22-1) may only be used when:

- Manufacturer's instructions do not prohibit an adapter and

- The adapter provides proper polarity and grounding to the appliance, with the adapter ground lug/wire securely attached to a grounding source, such as:
  - A grounded receptacle
  - A grounded electrical box
  - An alternate grounding conductor per Section 1 General Installation Guidelines, Grounding Guidelines

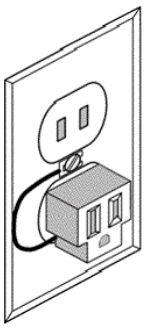


FIG. 22-1: GROUNDED THREE-PRONG ADAPTER

4.2.4(d) Extension cord

4.2.4(d1) One extension cord may be used only when allowed by the appliance manufacturer's instructions.

- Use the shortest feasible length, with a 6' maximum.

4.2.4(d2) The appliance cord and extension cord shall not be draped over a countertop or furnishings in a manner that allows access to children or creates a tripping hazard.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 There are no multi-family whole-building installation requirements. The conventional home (single-family) criteria apply to all multi-family whole-building installations.

6.1.3 When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.3(a) Common area installation (e.g., in a shared kitchen, entertainment room, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Test the unit to ensure it is operating properly.

8.1.2 Check the outlet for proper grounding.

8.2. Client Education

8.2.1 Provide occupant education that addresses:

8.2.1(a) The importance of checking meal and recipe instructions regarding the power level required

8.2.1(b) Cooking limitations at lower wattages (longer cooking time, inability to properly cook some items, etc.)

8.3. Clean-Up and Disposal Requirements

8.3.1 An existing inoperable/damaged microwave shall be removed from the home and disposed of properly:

8.3.1(a) Remove the microwave oven door to permanently disable the unit and

8.3.1(b) Dispose of the decommissioned appliance in accordance with state and local regulations

8.3.2 Remove all packaging and debris from the work site.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 10 years

9.1.2 DOE: Not applicable to this measure

9.2 Counter space shall be considered when selecting the microwave oven capacity and power rating.

9.3 All units shall:

9.3.1 Be Underwriters Laboratories (UL)-listed countertop models

9.3.2 Have electronic controls with ten or more power settings

9.3.3 Have a minimum capacity of 0.7 cu. ft.

9.3.4 Have a power rating of 800–1100 watts

9.3.5 Have a grounded, three-prong power cord

9.4 If needed, an extension cord shall be:

9.4.1 New, UL-listed, and in accordance with the manufacturer’s specifications

9.4.2 A three-conductor cord with three-prong grounding plug

9.4.3 Rated appropriately for the appliance, minimum 14 American Wire Gauge (AWG)

9.4.4 The shortest feasible length with a maximum length of 6'

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

23. Refrigerators

Table of Contents

Refrigerators

1. MEASURE OBJECTIVE

1.1 Repair or replacement of a home's primary refrigerator will increase its energy efficiency.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 The refrigerator does not qualify for replacement but has one or more damaged door gaskets

2.2. Install

2.2.1 The manufacture date is prior to 2001 or

2.2.2 The unit is inoperable and cannot be repaired or

2.2.3 The CSD 540E Single-Family Refrigerator SIR Calculation Worksheet shows a savings-to-investment ratio (SIR) ≥1.0 for a refrigerator of any age or

2.2.4 The unit is unable to maintain a safe food temperature

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1. Do Not Repair

3.1.1 The existing refrigerator will be replaced

3.1.2 The repair is not related to energy conservation (e.g., replacement of door handle, refrigerator racks, etc.)

3.1.3 The refrigerator is on loan to the client or is a rental

3.1.4 The electrical outlet used by the existing refrigerator is hazardous and cannot be repaired

3.1.5 The repair would violate the Appendix E Health and Safety Requirements

3.1.6 The client refuses after measure benefits have been explained by the assessor

3.2. Do Not Install

3.2.1 The existing refrigerator is on loan or is a rental

3.2.2 No refrigerator exists in the home

3.2.3 The electrical outlet used by the existing refrigerator is not properly installed (e.g., it is hazardous, is not grounded, or has reversed polarity) and cannot be repaired

3.2.4 No appropriate location is available for one or more of the following reasons:

3.2.4(a) Inadequate access is available to remove the existing unit and install a new unit

3.2.4(b) The flooring is structurally inadequate to properly support the weight of the unit

3.2.4(c) Clearance requirements cannot be met

3.2.4(d) The refrigerator cannot be installed in a level, plumb, and stable condition

3.2.5 Installation would violate the Appendix E Health and Safety Requirements

3.2.6 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Documentation of refrigerator replacement conditions (including temperature readings of unsafe food temperatures) must be recorded on the CSD 540E calculator and kept in the client file.

4.1.1(a) Look-Up Resources

4.1.1(a1) "Look-up" usage data from the website at https://www.energy.gov/eere/wap/articles/refrigerator-and-freezer-energy-rating-database-search-tool will be entered in the CSD 540E form.

4.1.1(a2) For models that were produced over multiple years, if the year of manufacture cannot be accurately determined online, the manufacturer must be contacted directly (i.e., by phone or email) to pinpoint the correct year using the model number and serial number.

4.1.2 Audited Measures

4.1.2(a) When this measure will be installed under the Low Income Home Energy Assistance Program (LIHEAP) and an energy audit is performed, if the measure will be fully leveraged or co-funded it must comply with Appendix D Energy Audit/Priority List Protocol.

4.1.2(b) When this measure is paid for by LIHEAP, or is co-funded with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply.

4.1.3 Sizing Limitations

4.1.3(a) Sizing limitations for replacement refrigerators shall be in accordance with Table 23-1 except when installation of a larger unit is justified by an SIR ≥1.0.

4.1.3(a1) The maximum capacity of any replacement refrigerator shall be 23 cu. ft.

TABLE 23-1: REPLACEMENT REFRIGERATOR UNIT SIZE LIMITATIONS

Replacement Unit Size	Criteria
15–17 cu. ft.	One or two bedrooms with up to three residents
18–20 cu. ft.	Three bedrooms with up to five residents or Two bedrooms with four residents
21–23 cu. ft.	Four or more bedrooms or Five or more residents

4.1.4 Repair

4.1.4(a) Damaged door gaskets shall be replaced to improve operating efficiency.

4.1.4(b) Repair of issues not related to energy conservation (e.g., replacement of door handle, refrigerator racks, etc.) is not allowed.

4.1.5 Install

4.1.5(a) Unsafe food temperatures

4.1.5(a1) Multiple temperature readings must be taken over a 2–3-hour period, approximately every 20 minutes.

- Unsafe storage temperatures are:
  - In the refrigerator: >40°F and/or
  - In the freezer: >5°F

4.1.5(b) Second refrigerator

4.1.5(b1) If a second refrigerator is removed when the primary refrigerator is replaced, the storage capacity of the replacement refrigerator can be increased by 2 cu. ft.

- Client permission is required to remove the second refrigerator.

- The maximum refrigerator capacity of 23 cu. ft. shall not be exceeded without an approved CSD waiver.

4.1.5(c) Electrical safety requirements

4.1.5(c1) Replacement of an ungrounded outlet will only be performed in conjunction with measure installation.

4.1.5(c2) Overcurrent protection and conductor size must be adequate.

4.1.5(c3) The refrigerator must be plugged directly into a dedicated receptacle that is properly grounded and not protected by a ground fault circuit interrupter (GFCI).

- Exception: The refrigerator may be plugged into a shared receptacle, but the amperage rating of the new refrigerator cannot exceed that of the existing refrigerator.

4.1.5(c4) If the receptacle cover plate is cracked, damaged, or missing, a new one shall be installed (Fig. 23-1).

4.1.5(c5) Permanent three-prong adapters are not allowed.

4.1.5(c6) If an extension cord is needed, it must:

- Be allowed by the manufacturer
- Comply with the Material Specifications

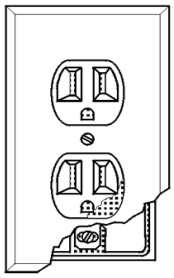


FIG. 23-1: REPLACE MISSING OR DAMAGED COVER PLATES

4.2. Installation Procedure

4.2.1 Repair

4.2.1(a) Replace damaged refrigerator door gaskets that do not provide a full and complete seal.

4.2.2 Install

4.2.2(a) Appliances infested with pests will be enclosed before being moved.

4.2.2(b) Installation must not damage the floor covering or interior finishes.

4.2.2(c) The appliance must fit in the available space without blocking access to light switches, cabinets, etc.

4.2.2(d) If the refrigerator is plugged into an ungrounded receptacle, replace it with a grounded receptacle.

4.2.2(e) Replace a broken or missing cover plate on the outlet for the replacement refrigerator.

4.2.2(f) Install the refrigerator in a level, plumb, and stable position.

4.2.2(f1) Adjust the leveling screws on the refrigerator accordingly.

4.2.2(f2) Use supplementary supports (e.g., shims) as needed.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 This measure may be installed in multi-family common areas (e.g., in a kitchen, entertainment room, etc. within the same thermal boundary as the dwelling units) when justified by energy audit for a whole-building project, per Appendix D Energy Audit/Priority List Protocol.

6.1.3(a) Common area installation is not allowed when only an individual unit in a multi-family building will be served.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 To assess for this measure as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.1(a) The form will determine if the measure will be installed in the Audit path or the Priority List (PL) path.

7.1.1(b) When assessing for this measure for the Audit path, measure feasibility will be decided by the audit with a Measure savings-to-investment ratio (SIR) and Dwelling SIR.

7.1.1(b1) The refrigerator must be modeled in the energy audit.

7.1.1(c) When assessing for the measure in the PL path, the feasibility will be based on building type and characteristics. Final justification is required using the CSD 540E Single-Family Refrigerator SIR Calculation Worksheet.

7.1.1(c1) PL measures are classified as Mandatory or Optional based on building type.

- Mandatory measures on the Priority List path must be installed when feasible, or the dwelling shall be deferred.
- Optional measures may be installed only after all feasible Mandatory PL measures have been installed.

7.1.1(c2) In the PL work scope, this measure requires justification with a Measure and Dwelling SIR ≥1.0 using the CSD 540E Single-Family Refrigerator SIR Calculation Worksheet.

7.1.2 If a client refuses a feasible Audit path Major measure, Mandatory Priority List path, or Health & Safety measure, the entire dwelling shall be deferred.

7.1.3 When this measure is fully leveraged or co-funded with LIHEAP, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/Priority List Protocol.

7.1.4 At least 10% of refrigerators replaced under the DOE program shall be metered using a metering device to collect consumption data.

7.1.4(a) Metering is also required for all units whose age cannot be determined from the refrigerator's ID label or when inefficient operation is suspected based on utility costs.

7.1.4(b) The metering device used shall be capable of showing wattage peaks (defrost cycles).

7.1.4(c) Metering should occur over a period of 20 hours or more to include a sampling of compressor and automatic defrost cycling. When the metering period must be short, the minimum duration is 2–3 hours and opening of the refrigerator door must be restricted as much as possible during the metering.

7.1.5 If a gas refrigerator is identified as having operational issues that create an unsafe environment, the refrigerator shall be repaired or replaced using alternative funding.

7.1.5(a) If alternative funding is not available, the appliance shall be removed with written client permission, or the condition requires home deferral.

7.1.5(b) The condition shall be documented on the CSD 542 Weatherization Deferral Form if alternative funding is not used to correct the condition.

7.1.6 Mobile Home Combustion Appliances

7.1.6(a) All combustion appliances left in place after weatherization in mobile homes must meet the Manufactured Home Construction and Safety Standards.

7.1.6(a1) If a client will not allow removal of an unsafe gas refrigerator from the home, deferral is required.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Temperature controls shall be set appropriately and demonstrated to occupants.

8.2. Client Education

8.2.1 If the client is not willing to give up a second refrigerator, education shall be provided regarding the energy cost to operate the second unit.

8.2.2 The occupant will be provided with:

8.2.2(a) Specific information on the proper maintenance of the equipment

8.2.2(b) Warranty information

8.2.2(c) Operation manuals

8.2.2(d) Installer contact information

8.2.3 If the refrigerator is plugged into an exposed duplex receptacle, educate the client that a maximum of one other appliance may be plugged into the second outlet, and that it shall not be used to plug in a toaster, microwave oven, hot plate, hair dryer, curling iron, or other high-wattage appliance.

8.3. Clean-Up and Disposal Requirements

8.3.1 Replaced parts and materials will be recycled or disposed of in accordance with federal, state, or local regulations.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 15 years

9.1.2 DOE: 15 years

9.2 Replacement Primary Refrigerators

9.2.1 The replacement appliance shall:

9.2.1(a) Be ENERGY STAR®–certified unit or must

9.2.1(a1) Meet California Energy Commission (CEC) energy efficiency standards and

9.2.1(a2) Have an SIR higher than the SIR for a comparable ENERGY STAR model

9.2.1(b) Be white in color

9.2.1(b1) Exception: Client-requested color is allowed if it is available at no additional cost.

9.2.1(c) Have the freezer on top, or be a side-by-side model in larger sizes when a top freezer is not available or a bottom freezer costs more

9.2.1(d) Not be equipped with an icemaker or water dispenser

9.2.1(e) Be sized in accordance with Table 23-1, except when installation of a larger unit is justified by an SIR ≥1.0

9.2.2 The maximum storage capacity of any replacement refrigerator shall be 23 cu. ft.

9.2.3 An extension cord, if needed, must be:

9.2.3(a) Underwriters Laboratories (UL)-listed

9.2.3(b) Three-conductor

9.2.3(c) Minimum 14 American Wire Gauge (AWG)

9.2.3(d) Maximum 6' long

10. WARRANTY

10.1 Manufacturer warranty—1 year

10.2 Contractor warranty—1 year

24. Ceiling Fans

Table of Contents

Ceiling Fans

1. MEASURE OBJECTIVES

1.1 Ceiling fans provide air distribution.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 No ceiling fan is present or

2.2.2 The existing ceiling fan is inoperable or

2.2.3 An existing ceiling fan has incandescent lighting that cannot accept light-emitting diode (LED) bulbs

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 An operable ceiling fan is already present

3.2 No acceptable location is available. (See Location and Clearances.)

3.3 The attic is not accessible when required to facilitate installation

3.4 No acceptable electrical circuit is available and one cannot be made available

3.5 An electrical hazard or unsafe structural condition is present that cannot be corrected within the program scope

3.6 Installation would violate the Appendix E Health and Safety Requirements

3.7 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 If knob-and-tube (K&T) wiring is present, refer to Section 1 General Installation Guidelines, Knob & Tube Wiring Guidelines for safety considerations.

4.1.2 Light Fixture

4.1.2(a) If a ceiling fan is installed in an existing overhead light location, the ceiling fan shall include a light kit.

4.1.2(b) When installing LED bulbs in the ceiling fan light fixture, refer to Section 26 LED Replacement Bulbs.

4.1.3 Sizing

4.1.3(a) Size the fan for the room dimensions and in accordance with the manufacturer's specifications.

4.1.3(b) When manufacturer specifications are not available, use Table 24-1.

TABLE 24-1: ENERGY STAR® CEILING FAN SIZING GUIDE

Room Dimensions	Ceiling Fan Diameter
Up to 75 sq. ft.	29–36"
76–144 sq. ft.	36–42"
144–225 sq. ft.	44"
225–400 sq. ft.	50–54"

4.1.4 Location and Clearances

4.1.4(a) Install ceiling fans:

4.1.4(a1) Within heated or cooled living areas, but not near an entrance door (Fig. 24-1).

4.1.4(a2) In bedrooms, but not near bunk beds

4.1.4(b) For all fans, blades must be a minimum of 84" from the floor.

4.1.4(c) The ends of the blades will be a minimum of 24" from all obstructions, including open cabinet doors and the adjacent ceiling.

Fig. 24-1: Correct Fan Locations

4.1.4(d) The bottom of the light fixture will be a minimum of 80" from the floor.

4.1.4(e) Use a flush-mount type fan when installed near or over a bed.

4.2. Installation Procedure

4.2.1 Install the ceiling fan in accordance with the manufacturer's instructions.

4.2.2 Mounting Methods

4.2.2(a) All fans will be mechanically secured to solid wood or manufactured metal mounting hardware.

4.2.2(b) Wooden block between ceiling joists:

4.2.2(b1) Secure the block to joists composed of at least 2x4 dimensional lumber.

4.2.2(b2) Attach the electrical box and ceiling fan securely.

4.2.2(c) Ceiling joist:

4.2.2(c1) Secure the electrical box and ceiling fan to joists composed of at least 2x4 dimensional lumber.

- Exception: Smaller joists are acceptable when a plywood mounting base can safely be installed.

4.2.2(d) Plywood mounting base:

4.2.2(d1) Use minimum ¾" plywood for the base (Fig. 24-2).

4.2.2(d2) The width of the base must be a minimum of half the joist spacing.

4.2.2(d3) Secure the base to the joists with two or more #8 screws that penetrate a joist at least 1".

4.2.2(d4) Secure the electrical box and fan to the plywood base or a joist.

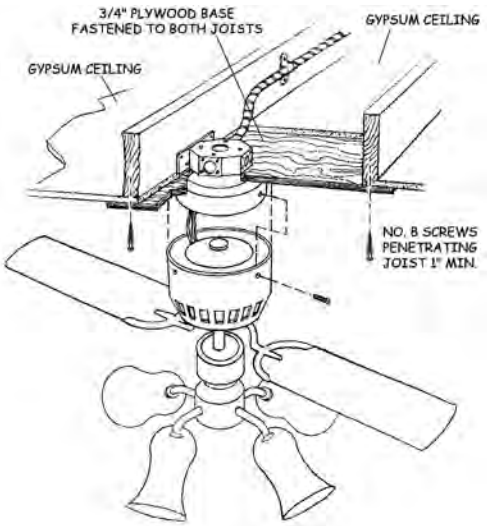


Fig. 24-2: Ceiling Fan Mounting with Plywood Mounting Base

4.2.2(e) Expansion bracket:

4.2.2(e1) A commercial expansion bracket may be used to secure the electrical box and fan to ceiling joists (Fig. 24-3).

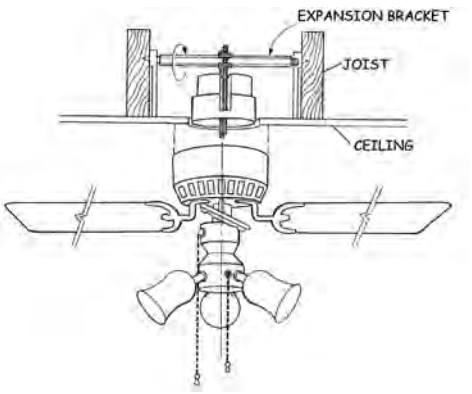


Fig. 24-3: Ceiling Fan Mounting with Expansion Bracket

4.2.3 Drop Rod

4.2.3(a) Use a drop rod for high ceilings unless prohibited by the fan manufacturer.

4.2.3(b) Size drop rods in accordance with Table 24-2.

TABLE 24-2: DROP ROD SIZING

Ceiling Height	Drop Rod Length
9'	12"
10'	18"
11'	24"
12'	36"
13'	48"

4.2.4 Electrical Wiring

4.2.4(a) All fans must be attached to a ceiling fan–rated electrical box.

4.2.4(b) Wiring must be safe, intact, and properly sized and have adequate overcurrent protection.

4.2.4(c) Existing wiring must be a minimum of 14-gauge copper or equivalent.

4.2.4(d) Exposed wiring must be housed in a raceway except when a swag chain is used.

4.2.4(e) Swag chain kit:

4.2.4(e1) Use a swag chain kit when hard-wiring is not possible.

4.2.4(e2) A properly connected separate grounding conductor must accompany the power cord unless a grounded three-conductor cord is used.

4.2.5 Existing Controls

4.2.5(a) Dimmers (Fig. 24-4), including a light dimmer on a remote control, will not be used to control:

4.2.5(a1) The fan motor

4.2.5(a2) Fan lighting unless it is listed for control by a dimmer

4.2.5(b) A separate speed controller must not be:

4.2.5(b1) Installed unless supplied with the fan or specified by the manufacturer

4.2.5(b2) Used to control the fan lighting

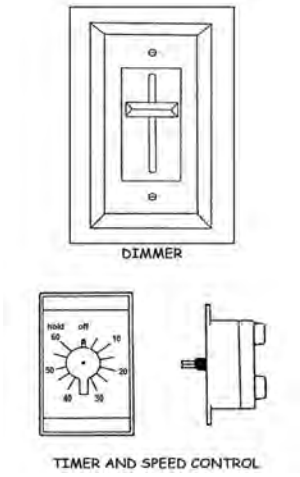


FIG. 24-4: CEILING FAN CONTROLLERS

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

5.1.2 Installation is not possible when the ceiling joists will not provide the required support.

5.1.3 A properly grounded electrical box in good condition must be present at the mounting location.

5.1.4 Mounting Methods

5.1.4(a) Ceiling joist

5.1.4(a1) Secure the electrical box and ceiling fan to the 2x4 or larger joist.

5.1.4(b) Mounting base

5.1.4(b1) A fan may be secured to smaller joists when:

- A plywood mounting base can safely be installed and
- The joists are capable of safely bearing the weight of the fan

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 There are no multi-family whole-building installation requirements. The conventional home (single-family) criteria apply to all multi-family whole-building installations.

6.1.3 When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.3(a) Common area installation (e.g., in a kitchen, entertainment room, reception area, etc.) for this measure is not allowed.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Fan and Light

8.1.1(a) Ensure the fan, light, and all controls operate properly.

8.1.1(b) Ensure the light kit set screws are tight.

8.1.2 Blade Balance

8.1.2(a) The fan must rotate smoothly without undue wobbling.

8.1.2(b) Balance the blades (e.g., using a supplied balancing kit) as needed.

8.2. Client Education

8.2.1 For all measures installed, supply the client with both verbal and written instructions for:

8.2.1(a) Proper operations and maintenance

8.2.1(b) Safety considerations

8.2.1(c) Warranty

8.3. Clean-Up and Disposal Requirements

8.3.1 Remove all replaced ceiling fans, fixtures, and parts from the property and dispose of them properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 10 years

9.1.2 DOE: Not applicable to this measure

9.2 Units shall:

9.2.1 Be ENERGY STAR–certified and Underwriters Laboratories (UL)-listed

9.2.2 Be ceiling-mounted units only

9.2.3 Meet 110-volt electrical requirements

9.2.4 Have three-speeds or variable speed control

9.2.5 Have separate fan and light switch controls on the fan when a light kit is present

9.3 The UL-listed fan unit shall:

9.3.1 Be capable of reversible fan action

9.3.2 Permit convenient consumer adjustment of the fan speed by one or more wall-mounted switches, a remote control, or readily accessible pull chains

9.3.2(a) The remote control shall be UL-listed and compatible with the fan.

9.4 Light kits shall be LED and meet the manufacturer's specifications.

10. WARRANTY

10.1 Manufacturer—3 years

10.2 Contractor—1 year

25. Tier 2 Advanced Power Strips

Table of Contents

Tier 2 Advanced Power Strips

1. MEASURE OBJECTIVES

1.1 A tier 2 advanced power strip (T2 APS) saves energy by turning off a television and peripheral devices when they are not in use. T2 APS installation is allowed in all housing types.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 A television and at least one peripheral device (e.g., digital video disk [DVD] player, television sound bar, game console, etc.) are present that can be connected to the switched (power-saver) outlets

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 An unsafe electrical condition or hazard is present at the receptacle or wiring (e.g., ungrounded outlet, decayed insulation, exposed wires, etc.) and cannot be corrected

3.2 Furniture cannot be moved to facilitate installation, and it will not be moved by the client. (The client shall be given the opportunity to move the furniture that would otherwise make installation unfeasible.)

3.3 Installation would violate the Appendix E Health and Safety Requirements

3.4 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 The client will be asked to power off devices that will be plugged into the T2 APS before the installation begins.

4.2. Installation Procedure

4.2.1 The T2 APS (Fig. 25-1) shall be:

4.2.1(a) Installed in a location that has good air circulation and is free of moisture sources, in line of sight, close to the television, and within normal operation of existing remote control(s).

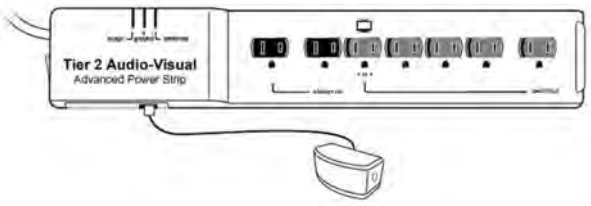


FIG. 25-1: TIER 2 AUDIOVISUAL ADVANCED POWER STRIP

4.2.1(b) Plugged directly into an acceptable receptacle—not into an extension cord, standard power strip, or surge protector

4.2.1(b1) The receptacle must be three-prong and properly grounded.

- No adapters are allowed.

4.2.1(b2) Only one T2 APS shall be plugged into a duplex receptacle.

4.2.1(c) No extension cord, power surge protector, or other APS shall be plugged into it.

4.2.2 T2 APS–Connected Devices

4.2.2(a) Devices that must be connected to the T2 APS are:

4.2.2(a1) A television as the primary device

4.2.2(a2) Peripheral devices recommended by the T2 APS manufacturer (e.g., DVD players, stereos, etc.)

4.2.3 T2 APS–Prohibited Devices

4.2.3(a) Devices that shall not be connected to the T2 APS are:

4.2.3(a1) Small appliances (e.g., heaters, lamps, toaster, coffeemaker, etc.)

4.2.3(a2) Computers, cable boxes, and digital video recorder systems (to prevent unnecessary re-booting and potential failure of these systems)

4.2.4 Power Cords

4.2.4(a) Power cords shall not:

4.2.4(a1) Be run through a wall

4.2.4(a2) Be secured in place with staples, tacks, tape, etc.

4.2.5 Any excess cord length shall be safely secured out of the way (e.g., with cable ties).

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 There are no multi-family whole-building installation requirements. The conventional home (single-family) criteria apply to all multi-family whole-building installations.

6.1.3 When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.3(a) Common area installation (e.g., in a lobby, entertainment room, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 With the client present, check the T2 APS to confirm proper operation.

8.2. Client Education

8.2.1 Instruct the client how to operate the T2 APS:

8.2.1(a) Following the T2 APS instructions, use the television infrared (IR) remote control to turn on the switched outlets.

8.2.1(b) Turn on all peripheral devices plugged into the switched outlets and the always-on outlets of the T2 APS.

8.2.1(c) With the television and peripheral devices turned on, press the power button on the television IR remote control to turn off the television.

8.2.1(c1) All switched devices should automatically turn off within 5 minutes.

8.2.1(c2) All always-on devices should remain on.

8.3. Clean-Up and Disposal Requirements

8.3.1 All packaging materials and other debris shall be removed from the premises.

8.3.2 Furniture and other household items moved for installation work shall be returned to their original positions.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 8 years

9.1.2 DOE: Not applicable to this measure

9.2 Approved materials shall:

9.2.1 Be listed to the latest Underwriters Laboratories (UL) 1449 standard, and be listed to the latest UL 1363 standard, if corded

9.2.2 Be IR-controlled with an IR remote sensor or an IR remote sensor and motion detector

9.2.3 Be rated for 120 volts and 15 amps

9.2.4 Provide a minimum of 1,000 joules of surge protection for all outlets

9.2.5 Have a resettable circuit breaker

9.2.6 Have a maximum standby power draw of 1 watt

9.3 The T2 APS shall be equipped with:

9.3.1 A “smart” power-saving function that automatically turns off power to all switched devices within 5 minutes after the television is turned off.

9.3.2 An adjustable timer (delay period) that:

9.3.2(a) Automatically turns off the television and switched outlets after a minimum 1-hour delay period if no activity is detected

9.3.2(b) Can be manually programmed for a longer delay period

9.3.2(c) Produces a warning signal that alerts the user before power to the television is turned off

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

26. LED Replacement Bulbs

Table of Contents

LED Replacement Bulbs

1. MEASURE OBJECTIVES

1.1 Light-emitting diode (LED) bulbs save energy over incandescent, compact fluorescent lamp (CFL), and halogen bulbs.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 An existing incandescent, CFL, or halogen bulb is used

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 Prohibited by the manufacturer of the LED or the fixture

3.2 LED bulbs are already in place

3.3 The electrical fixture (including box, switch, wiring, or other circuit components) is damaged, degraded, or unsecured or has bare wires present or wire nuts missing and repair is not possible within the program scope

3.4 The electrical fixture is unsafe or not code-compliant, such as being supported by an 18-gauge lamp cord (Fig. 26-1)

3.5 The LED would be installed outdoors and the fixture or bulb is not rated for use in the location (damp or wet)

3.6 The porcelain lamp base is broken or has a missing cap (Fig. 26-2)

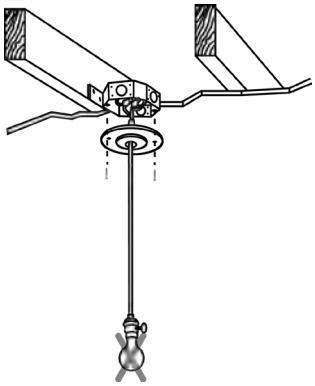


Fig. 26-1: Lamp Cord–Supported Bulb

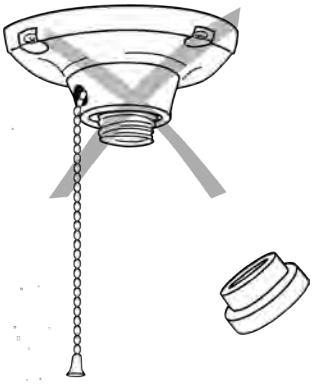


Fig. 26-2: Porcelain Lamp Base with Missing Cap

3.7 The fixture is not on the client's electric meter/bill

3.8 Installation would violate the Appendix E Health and Safety Requirements

3.9 The client refuses after the measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 All bulbs in a fixture shall be the same type.

4.1.2 Audited Measures

4.1.2(a) When this measure will be installed under the Low Income Home Energy Assistance Program (LIHEAP) and an energy audit is performed, if the measure will be fully leveraged or co-funded it must comply with Appendix D Energy Audit/Priority List Protocol.

4.1.2(b) When this measure is paid for by LIHEAP, or is co-funded with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply.

4.1.3 Light/lamp wattage shall not exceed the rated wattage of the fixture.

4.1.4 Follow the manufacturer's replacement restrictions and the maximum replacement wattages listed in Table 26-1.

4.1.5 LED bulbs must provide light output levels (lumens) sufficient to maintain pre-existing levels, in accordance with Table 26-1.

Table 26-1: Equivalent Wattage and Light Output of Incandescent, Halogen, CFL, and LED Bulbs

Light Output	Incandescent**	Halogen†	CFL**	LED**
250 lumens	25 watts	18 watts	4–9 watts	2–4 watts
450 lumens	40 watts	29 watts	8–12 watts	4–5 watts
800 lumens	60 watts	43 watts	13–18 watts	6–8 watts
1,100 lumens	75 watts	53 watts	18–22 watts	9–13 watts
1,600 lumens	100 watts	72 watts	23–30 watts	16–20 watts
2,600 lumens	150 watts	N/A	30–55 watts	25–28 watts

**Source: Eartheasy.com
†Source: Jacksonemc.com

4.1.6 Pendant light fixtures (chandeliers, wall pendants, etc.) shall remain level after installation of LED bulbs.

4.1.7 Prior to LED bulb installation, check the existing fixture for:

4.1.7(a) Hazardous electrical conditions

4.1.7(b) The maximum wattage allowed

4.1.7(c) Compatibility with the LED bulb manufacturer's specifications if the fixture is controlled by a dimmer switch, vacancy sensor, or other special controller

4.2. Installation Procedure

4.2.1 Bulbs shall be installed in fixtures in accordance with manufacturer's guidelines.

4.2.1(a) Replacement bulbs shall not be left with the customer for installation.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 Common area installation (e.g., in a kitchen, utility room, entertainment room, etc. within the same thermal boundary as the dwelling units) is allowed when justified by an energy audit for a whole-building project, per Appendix D Energy Audit/Priority List Protocol.

6.1.3(a) Common area installation is not allowed when only an individual unit in a multi-family building will be served.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 To assess for this measure as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.1(a) The form will determine if the measure will be installed in the Audit path or the Priority List (PL) path.

7.1.1(b) When assessing for this measure for the Audit path, measure feasibility will be decided by the energy audit with a Measure savings-to-investment ratio (SIR) and Dwelling SIR.

7.1.1(b1) LED bulbs and LED tube lights shall be modeled in the energy audit.

7.1.1(c) When assessing for the measure in the PL path, the feasibility will be based on building type and characteristics.

7.1.1(c1) PL measures are classified as Mandatory or Optional based on building type.

- Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.
- Optional measures may be installed only after all feasible Mandatory PL measures have been installed.

7.1.2 If a client refuses a feasible Audit path Major measure, Mandatory Priority List path, or Health & Safety measure, the entire dwelling shall be deferred.

7.1.3 When this measure is fully leveraged or co-funded with LIHEAP, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/ Priority List Protocol.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2(a) Excerpted from 2017 SWS 7.8003.1:

7.2.2(a1) All bulbs, fixtures, and controls will be appropriate for the intended application (e.g., enclosed, orientation, dimmable, potential for breakage, indoor, and outdoor)

7.2.2(a2) All bulbs, fixtures, and controls will be selected to provide the brightness and light quality required in that application (e.g., task lighting, trip-and-fall hazards, night-lights)

7.2.2(a3) Bulb replacements will be chosen based on expected durability, light quality, and lifetime energy use of the bulb

7.2.3 Mobile Home

7.2.3(a) Requirements for mobile homes are the same as those for single-family homes.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 The installer and quality control inspector shall test all installed LED bulbs and confirm that they perform properly and the lighting level is adequate for the client.

8.2. Client Education

8.2.1 None

8.3. Clean-Up and Disposal Requirements

8.3.1 All replaced bulbs and fixtures shall be removed from the home and disposed of in accordance with the requirements of the local jurisdiction.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP:

9.1.1(a) Interior bulb—16 years

9.1.1(b) Exterior bulb—15 years

9.1.2 DOE: Exterior and interior bulbs—15 years

9.2 All LED bulbs shall be:

9.2.1 ENERGY STAR®–certified

9.2.2 Underwriters Laboratories (UL)–listed or equivalent

9.2.3 Omni-directional (capable of at least 300º light direction)

9.2.4 Dimmable to less than 10% of output for those locations on dimming switches

9.2.5 Selected for a specific location as shown in Table 26-2.

TABLE 26-2: COLOR-CORRELATED TEMPERATURE (CCT) BY INSTALLATION LOCATION

Installation Location	CCT in Degrees Kelvin (K)	Lighting Characteristic
Indoors	2700K	Soft white
	3000K	Warm white
	3000K	Neutral white
	3500K	Natural white
Outdoors	4000/4100K	Cool white
	5000/6500K	Daylight

9.3 Installed LEDs must have a minimum Color Rendering Index (CRI) of 90.

9.4 LED bulbs for enclosed fixtures must be labeled JA8-2019-E.

9.5 For outdoor locations: Protected from the weather per manufacturer's instructions, and the bulb and fixture shall be rated for damp or wet locations.

9.6 Dimmers, photo sensors, timers (mechanical or solid state), and vacancy or occupancy sensors: LED bulbs may be installed only when the LED is compatible.

10. WARRANTY

10.1 Manufacturer—3 years

10.2 Contractor—1 year

27. LED Night-Lights

Table of Contents

LED Night-Lights

1. MEASURE OBJECTIVES

1.1 Light-emitting diode (LED) night-lights save energy by illuminating an area only when there is insufficient ambient light.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 Nighttime illumination is needed in a location in the home or

2.2.2 The existing night-light is defective

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The receptacle is not properly secured, is defective, or is unsafe and the defect cannot be corrected within the scope of the program

3.2 There is a duplex receptacle but the night-light would cover up both outlets

3.3 The proposed location is in a storage room or closet

3.4 An operational LED night-light is already present

3.5 No suitable location is available

3.6 Installation would violate Appendix E Health and Safety Requirements

3.7 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 An LED night-light shall only be installed in an interior/indoor receptacle that is safe and properly secured in an electrical box with an intact cover plate.

4.1.1 (a) If the receptacle is switched, the switch must function properly.

4.1.1 (b) The night-light shall not be plugged into an extension cord.

4.1.2 Night-lights shall be located in accordance with the client's needs.

4.2. Installation Procedure

4.2.1 LED night-lights shall be installed in receptacles in accordance with manufacturer's guidelines.

4.2.1 (a) Night-lights shall not be left with the customer for installation.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 There are no multi-family whole-building installation requirements. The conventional home (single-family) criteria apply to all multi-family whole-building installations.

6.1.3 When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.3(a) Common area installation (e.g., in a lobby, hallway, kitchen, laundry room, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Test all installed LED night-lights for proper operation.

8.1.2 Cover the photo sensor (Fig. 27-1) to simulate darkness.

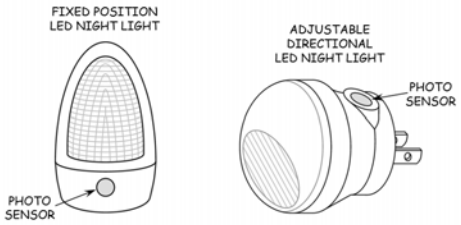


FIG. 27-1: NIGHT-LIGHT MODELS AND SENSOR LOCATION

8.1.3 Devices unplugged to allow night-light installation shall be moved to another outlet.

8.2. Client Education

8.2.1 The client will receive operation instructions.

8.2.2 The manufacturer's written warranty will be provided when available.

8.3. Clean-Up and Disposal Requirement

8.3.1 Packaging materials that include manufacturer's instructions or warranty information will be given to the customer.

8.3.2 All other installation and packaging materials shall be removed from the premises and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 16 years

9.1.2 DOE: 16 years

9.2 All LED night-lights shall be:

9.2.1 Maximum wattage 0.5 watts

9.2.2 Underwriters Laboratories (UL)–listed or equivalent

9.2.3 Equipped with an integrated photoelectric (auto-on) switch that turns on the night-light when the room is dark

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

28. LED Hard-Wired Fixtures and Downlight Kits

Table of Contents

LED Hard-Wired Fixtures and Downlight Kits

1. MEASURE OBJECTIVES

1.1 High-efficacy light-emitting diode (LED) fixtures will provide energy savings compared to incandescent, compact fluorescent lamp (CFL), high-intensity discharge (HID), or halogen fixtures for the same light output.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 The light source in the existing fixture:

2.2.1(a) Is incandescent, CFL, HID, or halogen and

2.2.1(b) Would be used at least two hours per day and is either:

2.2.1(b1) An operable or inoperable surface-mount, hardwired fixture or

2.2.1(b2) An operable recessed ceiling downlight fixture

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 Screw-based LED bulbs can be installed in the existing surface-mount fixture

3.2 The new LED fixture is not compatible with the existing circuit dimmer/sensor and the dimmer/sensor is not being upgraded

3.3 Installation would violate Appendix E Health and Safety Requirements

3.4 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 When required by the local jurisdiction, a building permit to replace an existing lighting fixture shall be obtained.

4.1.2 The light output (lumen) level shall be sufficient to maintain the existing light level unless a lower level is acceptable to the client.

4.1.3 Electrical Requirements

4.1.3(a) Fixtures shall:

4.1.3(a1) Be installed only in 110–120-volt circuits

4.1.3(a2) Have a readily accessible on/off switch

4.1.4 Controllers

4.1.4(a) When the LED fixture is controlled by a timer, dimmer, occupancy sensor, or vacancy sensor:

4.1.4(a1) Verify the dimmer/sensor is compatible with the replacement fixture or

4.1.4(a2) Replace the existing dimmer/sensor with a compatible controller

4.1.4(b) Vacancy sensors shall be installed in accordance with Section 31 Vacancy Sensor Switches.

4.2. Installation Procedure

4.2.1 Surface-Mount Fixtures

4.2.1(a) Interior installations:

4.2.1(a1) Interior-mount fixtures include but are not limited to hard-wired interior wall/sconces, vanity lights, ceiling fixtures, and downlight retrofit kits.

4.2.1(a2) All wiring not inside a building cavity shall be housed in a raceway.

4.2.1(b) Exterior installations (Fig. 28-1):

4.2.1(b1) Exterior-mount fixtures include, but are not limited to, hard-wired porch lights and security lights.

4.2.1(b2) All exposed wiring shall be housed in a watertight conduit.

4.2.1(b3) Installation must prevent water from entering or accumulating in wiring compartment, lamp holder, or electrical parts.

Fig. 28-1: Example of a Damp Location

4.2.1(c) Surface-mount fixture wiring:

4.2.1(c1) Ensure that the wiring is not damaged (e.g., no slices, cuts, nicks, etc.).

4.2.1(c2) Splices shall be contained within a fixture, junction box, etc.

4.2.1(c3) Twist-type pressure splicing connectors (e.g., wire nuts):

4.2.1(c4) “Poke-in” and “stab-in” type electrical connections may be used in lieu of twist-type splicing connectors.

4.2.1(c5) If wire materials are dissimilar (such as aluminum and copper), refer to Section 1 General Installation Guidelines, Electrical Guidelines.

4.2.1(d) Grounding:

4.2.1(d1) Refer to Section 1 General Installation Guidelines, Grounding Guidelines.

4.2.1(d2) When a grounding conductor is not available in the fixture box:

- A plastic fixture without grounding requirement may be installed or
- A ground fault circuit interrupter (GFCI)–protected switch may be installed in lieu of grounding

4.2.1(e) Securing surface-mount fixtures (Fig. 28-2 and Fig. 28-3):

4.2.1(e1) Secure the fixture to a mounting plate, electrical box, or structural members.

4.2.1(e2) Additional fasteners/screws are not required for fixtures attached by a properly installed threaded nipple and nut.

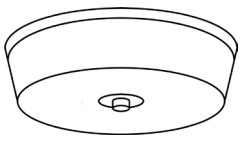


Fig. 28-2: Ceiling-Mount LED Fixture

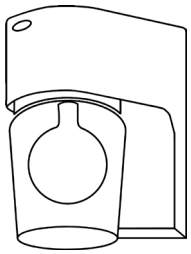


Fig. 28-3: Wall-Mount LED Fixture with Photocell Control

4.2.2 Downlight Retrofit Kits

4.2.2(a) Securing retrofit kits (Fig. 28-4):

4.2.2(a1) The kit shall fit properly into the existing housing with room for electrical conductors and connectors.

4.2.2 (a2) Attachment hardware (e.g., torsion springs or brackets) shall be compatible with the housing.

4.2.2 (a3) The trim shall completely cover the opening surrounding the housing.

4.2.2 (a4) Seal any gaps between the existing luminaire housing and the ceiling with caulk.

4.2.2 (a5) The kit shall be sealed with a manufacturer supplied gasket between the luminaire housing and the kit trim to seal air leak paths between conditioned and unconditioned space.

4.2.2 (b) Electrical connection:

4.2.2 (b1) Wiring shall be routed into the housing and secured without pinching or damaging the conductors or insulation.

FIG. 28-4: LED DOWNLIGHT RETROFIT KIT

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 When the measure will be included in a multi-family whole-building project, Appendix F Multi-Family Standards applies.

6.1.3 Common area installation (e.g., in a kitchen, laundry room, hallway, etc. within the same thermal boundary as dwelling units) is allowed when justified by an energy audit for a whole-building project, per Appendix D Energy Audit/Priority List Protocol.

6.1.3 (a) Common area installation is not allowed when only an individual unit in a multi-family building will be served.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Verify that all installed fixtures, controllers, and sensors operate properly.

8.2. Client Education

8.2.1 Demonstrate proper operation and maintenance of the fixture.

8.2.2 Provide warranty and operation instructions to the client.

8.3. Clean-Up and Disposal Requirements

8.3.1 All replaced components shall be removed from the premises and recycled/disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP:

9.1.1(a) Interior fixtures—16 years

9.1.1(b) Exterior fixtures—15 years

9.1.2 DOE: Not applicable to this measure

9.2 All Fixtures

9.2.1 All fixture types must:

9.2.1(a) Be Underwriters Laboratories (UL)-listed and compliant with Title 24 requirements

9.2.1(b) Utilize UL-listed, properly sized connectors

9.3 All Outdoor Fixtures:

9.3.1 Fixtures marked “suitable for damp locations” shall be installed out of direct contact with precipitation in partially protected locations (e.g., under canopies, in closed porches, and in carports).

9.3.2 Fixtures marked “suitable for wet locations” may be installed in damp locations and in unprotected outdoor locations where the fixture is installed >4' above the ground.

9.3.3 Light Controls

9.3.3(a) Exterior fixtures shall be controlled by:

9.3.3(a1) Photo-control and motion sensor or

9.3.3(a2) Motion sensor or automatic time switch control

9.3.4 Any installed vacancy sensors, motion sensors, and dimmers must be certified to comply with Title 20 Appliance Efficiency Regulations.

9.4 LED bulbs installed in fixtures shall be:

9.4.1 ENERGY STAR®–certified

9.4.2 Listed in the California Energy Commission (CEC) Lighting Database

9.4.3 Marked with “JA8-2019” (“JA8-2019-E” for enclosed and recessed fixtures) per Title 24

9.4.4 Labeled “dimmable” when controlled by a dimmer

9.5 The correlated color temperature (CCT) in Table 28-1 may be used to select the LED fixture most suitable to the customer’s preference.

TABLE 28-1: LED FIXTURE CCT CHARACTERISTICS

Installation Location	CCT in Degrees Kelvin (K)	Lighting Characteristic
Indoors	2700K	Soft White
	3000K	Warm White
	3000K–3500K	Neutral Natural White
Outdoors	4000/4100K	Cool White
	5000K–6500K	Daylight

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

29. LED Torchieres

Table of Contents

LED Torchieres

1. MEASURE OBJECTIVE

1.1 Light-emitting diode (LED) torchieres use much less electricity than halogen, fluorescent, and incandescent torchiere lamps.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 An LED torchiere shall only be installed to replace an existing torchiere (operable or inoperable) that contains an incandescent, halogen, or fluorescent light source that cannot be replaced with an LED equivalent bulb.

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The electrical circuit is controlled by a non-compatible dimmer or solid-state timer

3.2 An acceptable, safe electrical outlet is not available, or an electrical hazard is present that cannot be repaired

3.3 The fixture can accept an LED bulb

3.4 Installation would violate Appendix E Health and Safety Requirements

3.5 The client refuses after measure benefits have been explained by the assessor

3.5.1 If occupants do not like the light level or appearance of the lamp, fixture installation is not possible.

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Outlet Cover

4.1.1 (a) A broken or missing outlet cover pertaining to the LED torchiere will be replaced before the measure is installed.

4.1.2 Electrical Supply

4.1.2 (a) A lamp with a polarized plug will be plugged into a properly installed polarized two-prong receptacle (one slot is wider than the other) or a three-prong grounded receptacle (Fig. 29-1).

4.1.2 (b) The lamp's plug will not be altered to fit a non-polarized receptacle.

4.1.2 (c) If the lamp is plugged into a multi-plug adapter, the adapter will be in good condition and polarized to match the receptacle.

4.1.2 (d) Extension cord

4.1.2 (d1) An extension cord may be used only when necessary to place the LED torchiere in an acceptable location and when its use is not prohibited by the lamp manufacturer.

4.1.2 (d2) The extension cord will be:

- Underwriters Laboratories (UL)-listed and polarized (one blade is wider than the other)
- In conformance with manufacturer's instructions, if addressed
- Rated appropriately for the torchiere, minimum 16 American Wire Gauge (AWG)

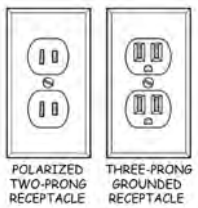


FIG. 29-1: APPROPRIATE RECEPTACLE STYLES

- The shortest feasible length, up to 6' maximum

4.2. Installation Procedure

4.2.1 Assembly and Installation

4.2.1(a) Lamp

4.2.1(a1) The LED torchiere lamp must be fully assembled, be plugged in, and operate properly.

4.2.1(b) Cord

4.2.1(b1) The appliance cord, and extension cord if applicable, will be located away from foot traffic to avoid creating a tripping hazard (Fig. 29-2).

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

FIG. 29-2: CORRECT USE AND LOCATION OF AN EXTENSION CORD

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 There are no multi-family whole-building installation requirements. The conventional home (single-family) criteria apply to all multi-family whole-building installations.

6.1.3 When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.3(a) Common area installation (e.g., in a lobby, hallway, kitchen, laundry room, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Ensure the lamp is plugged in and operating properly.

8.2. Client Education

8.2.1 The client will receive operation instructions.

8.2.2 The manufacturer’s written warranty will be provided when available.

8.3. Clean-Up and Disposal Requirements

8.3.1 All replaced halogen and incandescent torchiere lamps and fixtures will be demanufactured, recycled, and disposed of in accordance with the requirements of the local jurisdiction.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 4 years

9.1.2 DOE: Not applicable to this measure

9.2 LED wattage shall:

9.2.1 Be selected based on the equivalent light output of the incandescent, fluorescent, or halogen fixture to be replaced or

9.2.2 Be dimmable

9.3 All LED torchiere replacements shall have a lighting efficacy of 61 lumens per watt.

9.4 The LED torchiere lamp will be:

9.4.1 UL-listed or equivalent

9.4.2 ENERGY STAR®–certified

10. WARRANTY

10.1 Manufacturer warranty—1 year

10.2 Contractor warranty—1 year

30. Future Measure Placeholder

This Section is not applicable at this time and is reserved for a future measure.

31. Vacancy Sensor Switches

Table of Contents

Vacancy Sensor Switches

1. MEASURE OBJECTIVES

1.1 A vacancy sensor switch (VSS) saves energy by turning off lights when a room is unoccupied.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure

2.2. Install

2.2.1 A light fixture is in an intermittently occupied location with incandescent, halogen, light-emitting diode (LED), or compact fluorescent lamp (CFL) lighting and

2.2.2 The location is a family room, living room, dining room, bathroom, kitchen, laundry room, utility room, or garage and

2.2.3 The VSS will be installed in the same room as the light it controls

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 A functional VSS or dimmer is already in place

3.2 A qualifying location, light, or circuit is not present or not operational

3.3 Physical risk to the occupant may occur if the sensor fails (such as in a stairway)

3.4 Physical limitations will impede the occupant's ability to operate the switch

3.5 The electrical box cannot physically contain the VSS

3.6 The switched load exceeds the maximum amperage specified by the sensor manufacturer

3.7 A functional grounding conductor is not present when required by the manufacturer

3.8 The room is continually occupied

3.9 A forced air register or ceiling fan is within 6' of the switch, unless allowed by the manufacturer

3.10 The switch will control any of the following devices:

3.10.1 Ceiling fan

3.10.2 Lighting in closets, unless the switch is located inside the closet

3.10.3 Switches that must remain on, such as those controlling mechanical ventilators or other medical equipment

3.10.4 Security lighting or outdoor lighting

3.10.5 Emergency lighting fixtures

3.11 Installation would violate Appendix E Health and Safety Requirements

3.12 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 VSS may be installed in all housing types, including renter-occupied homes.

4.1.2 A VSS with an integral LED night-light feature may be installed where the occupant requests nighttime illumination.

4.1.3 When controlling a qualifying bathroom light and exhaust fan with one sensor, install a dual-load VSS rated for the fan load.

4.1.4 Electrical Requirements

4.1.4(a) The electrical circuit must be 110–120 volts, safe, and properly sized with adequate overcurrent protection to support the installation of appliances and other electrical measures.

4.1.5 VSS Selection

Select and locate the VSS according to the room's characteristics and the VSS specifications, including:

4.1.5(a) Electrical load within minimum and maximum limits of VSS capacity

4.1.5(b) Acceptable range and coverage area of the sensor

4.1.5(c) Type of occupant use (walking, reading, computer use, etc.)

4.1.5(d) Obstacles and hard surfaces in the room

4.1.5(e) Magnitude of motion:

4.1.5(e1) Minor motion (reading, writing, and hand movements), or

4.1.5(e2) Major motion (full-body and walking)

4.1.5(f) Ability to sense occupants and not turn off lights while the room is still occupied ("false off")

4.1.5(g) Located to not monitor the area outside the door (which can cause nuisance switching)

4.1.5(h) Passive infrared (PIR) VSS:

4.1.5(h1) Shall be installed only in locations with an unobstructed line-of-sight of the entire room (Fig. 31-1)

4.1.5(h2) Is more sensitive to lateral (side-to-side) motion than ultrasonic (US) VSS

4.1.5(h3) Is suitable for smaller, enclosed spaces

4.1.5(h4) Is not suitable for locations:

- With low motion levels (e.g., office, computer area, or reading area)
- Where obstacles can block the sensor's view

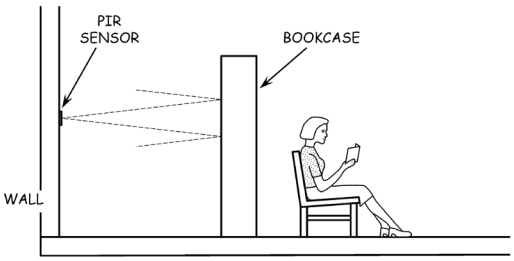


FIG. 31-1: PIR SENSORS ARE NOT USED WHEN OBSTACLES ARE PRESENT

4.1.5(i) Ultrasonic VSS:

4.1.5(i1) Is best in rooms with open spaces, obstructions, and hard surfaces

4.1.5(i2) Does not require occupants to be within its line of sight because its high-frequency sound can detect movement even around corners

4.1.5(i3) Has high sensitivity to minor movement, making it more suitable for areas with low motion (e.g., typing, writing, reading)

4.1.5(i4) Has a larger coverage area than a PIR sensor

4.1.5(i5) Is more sensitive to motion toward or away from the sensor than a PIR sensor

4.1.5(j) Dual technology (combination PIR/US) VSS:

4.1.5(j1) Is allowed in any location that conforms to the installation criteria and the manufacturer's recommendations

4.1.5(j2) Provides increased flexibility and accuracy

4.1.5(j3) Can reduce false-on/-off nuisance switching

4.2. Installation Procedure

4.2.1 Before replacing an existing switch with a VSS, turn off power to the switch box.

4.2.2 Verify that the controlled circuit is operational and properly grounded when grounding is required.

4.2.3 All VSS shall replace existing wall-mount light switches.

4.2.4 Total switched wattage shall be at least 40 watts and shall not exceed the manufacturer's load rating.

4.2.5 The VSS grounding lead must be properly connected to the system grounding conductor, when present.

4.2.6 Securely tighten screw-terminal wire attachments with a conductor wrapped around the screw no more than 360º.

4.2.7 Aluminum (Al) and copper (Cu) wires shall only be spliced together using Al/Cu wire connectors (and anti-oxidant paste when required) in accordance with the manufacturer's instructions and code.

4.2.8 The switch cover plate shall match the color of the VSS.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.3(a) Common area installation (e.g., in a lobby, hallway, kitchen, laundry room, etc.) is not allowed for this measure.

7. DOE–SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Each VSS will be tested for proper set-up and performance.

8.1.2 Time delay and sensitivity shall be set based on conditions at the residence.

8.1.2(a) Default delays (Fig. 31-2):

8.1.2(a1) 15 minutes for standard light controls

8.1.2(a2) 30 minutes for a dual-load VSS for a bathroom exhaust fan

8.2. Client Education

The customer shall be provided with:

8.2.1 Instructions for operation of the VSS

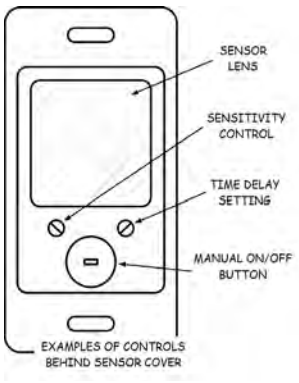


FIG. 31-2: EXAMPLE OF A SWITCH-BOX VACANCY SENSOR

8.2.2 Written instructions and warranty documents

8.3. Clean-up and Disposal Requirements

8.3.1 All replaced items, scraps, and other debris resulting from the VSS installation shall be removed from the premises using lead-safe practices when applicable.

8.3.2 Furniture and other household items moved for installation work shall be returned to their original positions.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 8 years

9.1.2 DOE: Not applicable to this measure

9.2 All VSS shall be:

9.2.1 Underwriters Laboratories (UL)–listed

9.2.2 Designed for installation in a wall-mount switch box

9.2.3 Title 24–compliant and listed in the California Energy Commission (CEC) Appliance Efficiency Database

9.2.4 Adjustable time delay, with maximum 20-minute delay

9.2.5 Manual on/automatic off

9.2.6 Not convertible to an occupancy sensor

9.2.7 Rated for use with the applicable lighting type

9.3 VSS for Specific Circuit Types

9.3.1 For single light–only circuits: Single pole

9.3.2 For light and exhaust fan controlled by one switch: Dual-load and rated for fan load

9.3.3 For multi-way and dimmable lighting circuits: Rated for use in such circuits

9.4 Sensor Types

9.4.1 Select the type appropriate for the location:

9.4.1(a) PIR

9.4.1(b) US

9.4.1(c) A combination of both sensor types

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

32. Infiltration Reduction

Table of Contents

Infiltration Reduction

1. MEASURE OBJECTIVES

1.1 Infiltration-reduction measures (IRMs) reduce the uncontrolled flow of air through the building envelope.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair/Install

2.1.1 Shell sealing measures are determined to be feasible as defined in Appendix C Shell Leakage Testing Protocol and CSD 704 Shell Leakage Data Sheet and

2.1.2 Cracks, gaps, and holes exist between conditioned and unconditioned spaces or between adjacent apartment units and fall into at least one of the following infiltration-reduction priorities (per Table 32-1):

2.1.2 (a) Priority 1—Catastrophic air leaks are present with a visible opening >5 sq. in.

2.1.2 (b) Priority 2—Attic and high-level air leaks are present

2.1.2 (c) Priority 3—Crawlspace and low-level infiltration is present

2.1.2 (d) Priority 4—Interior/mid-level infiltration is present and has a visible opening >⅝"

2.1.2 (e) Priority 5—Interior/mid-level infiltration is occurring with a visible opening ≤⅝"

2.1.2 (f) Priority 6—Exterior infiltration is present

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The dwelling has no heat source or cooling source

3.2 A combustion appliance safety (CAS) hazard or CAS fail exists and cannot be corrected as detailed in Appendix A Combustion Appliance Safety Protocol

3.3 The home is limited to non-infiltration measures only (the home is NIM) and shell sealing is not feasible per Appendix C Shell Leakage Testing Protocol

3.4 Mechanical ventilation assessment/installation is required as defined in Section 12 Mechanical Ventilation but cannot be installed

3.5 The dwelling envelope is damaged/deteriorated, or the home is being remodeled, and the thermal boundary is incomplete

3.6 Installation would violate the Appendix E Health & Safety Requirements

3.7 The client refuses after measure benefits have been explained by the assessor

3.8 The dwelling is:

3.8.1 A mobile home with an open combustion gas-burning space heater, water heater, or solid fuel burning space heater that draws combustion air from the living space or

3.8.2 A single family home with a solid fuel–burning space heater that draws combustion air from the living space

3.8.2 (a) Exception (for both mobile homes and single-family homes): Pressure diagnostics and IRMs shall be allowed when:

3.8.2 (a1) Pressure measurement shows the combustion appliance zone (CAZ) of each appliance is less negative than the house depressurization limit (HDL). (See procedures described in Appendix A Combustion Appliance Safety Protocol.)

3.8.2 (a2) Installed measures do not depressurize the CAZ beyond the HDL

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 All CAS hazards, CAS fails, or indoor air quality fails must be corrected before sealing activities begin, per Appendix A Combustion Appliance Safety Protocol.

4.1.2 Accessibility and Clearances

4.1.2(a) The attic or crawlspace shall be accessible, when required, in accordance with the clearance requirements identified in Section 1 General Installation Guidelines, Attic and Crawlspace Accessibility.

4.1.3 Prior to air sealing, an inspection will be conducted for mold, water leaks, and water damage.

4.1.3(a) All feasible moisture repairs will be completed before air sealing work begins.

4.1.3(a1) See Section 1 General Installation Guidelines, Limited Home Repair for specific examples of moisture repair.

4.1.4 Asbestos and Lead

4.1.4(a) If potential lead or asbestos hazards are present that could be impacted through infiltration activities, the dwelling shall be assessed in accordance with the Appendix E Health and Safety Requirements, Asbestos Policy and Lead Safe Weatherization (LSW) Policy.

4.1.5 Audited Measures

4.1.5(a) When this measure will be installed under the Low Income Home Energy Assistance Program (LIHEAP) and an energy audit is performed, if the measure will be fully leveraged or co-funded, it must comply with Appendix D Energy Audit/Priority List Protocol.

4.1.5(b) When this measure is paid for by LIHEAP, or is co-funded with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply.

4.1.5(b1) Door replacement as an energy efficiency upgrade is not permitted with LIHEAP or DOE funds.

4.1.6 Shell Sealing

4.1.6(a) Cracks and gaps in the envelope shall be sealed from the interior side whenever feasible.

4.1.6(b) Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections.

4.1.6(c) When a supplemental barrier is created (e.g., with a collar), it shall be secured as needed with mechanical fasteners (screws, staples, or nails) to ensure a complete and permanent seal.

4.1.6(d) Sealing work shall not create a fire hazard or other condition that conflicts with local code.

4.1.6(e) When applicable, sealing material shall be evenly tooled, with excess material removed, to ensure a clean appearance and adequate seal.

4.1.7 Sealing Thermal Bypasses

4.1.7(a) All air leakage locations (including duct leaks, shell leaks, and thermal bypasses) shall be sealed.

4.2. Shell Leakage Assessment

4.2.1 The dwelling shall be inspected to identify all thermal bypasses (areas of potential leakage from inside the living space), including in the wall(s) between the house and the garage, through ceilings, and between the floor and the crawlspace.

4.2.2 Assessors shall:

4.2.2(a) Identify all catastrophic shell leaks

4.2.2(b) Perform a visual inspection to identify gaps, cracks, and failed sealants

4.2.2(c) Conduct shell assessment per the Appendix C Shell Leakage Testing Protocol

4.2.3 Under LIHEAP, it is recommended that shell leakage testing be completed in all feasible dwellings. At a minimum, shell leakage test–driven air sealing shall be applied to at least 20% of single-family dwellings/manufactured housing and at least 5% of multi-family units.

4.2.3(a) Exception: Shell leakage testing is not required for multi-family buildings of four stories or more.

4.2.4 When a home is NIM, no shell testing or sealing shall be conducted until the issue that created the NIM condition is corrected.

4.2.5 Shell sealing activities—either prescriptive or as a result of shell leakage testing—shall be assessed and documented on the CSD 704 Shell Leakage Data Sheet.

4.3. Prioritization of Sealing Activities

4.3.1 Once leaks have been identified, sealing activities shall be prioritized per Table 32-1.

4.3.2 Infiltration-reduction priority levels shall be utilized in numerical order from Priority 1 to Priority 6.

4.3.3 In addition, shell sealing activities shall be performed in the order presented within each priority level, unless the activity is documented to be unfeasible.

4.3.4 If feasible sealing activities are skipped without written justification, those sealing activities will fail inspection.

4.3.5 Certain leaks may require more than one sealing technique to be resolved.

TABLE 32-1: PRIORITY LEVEL, SEALING ACTIVITY, AND INSTALLATION GUIDELINE DIRECTORY

Occupant Protection–Related Sealing		
Must be completed before shell leakage test or any shell sealing is performed.		
Priority	**Sealing Activity***	**Installation Guideline Section**
Occupant Protection	• Interior vent cover: Cooling source is too close to a furnace vent pipe terminal. Cover required to prevent byproduct infiltration. • CAS patching: Seal gaps/holes in walls separating a combustion appliance from the living space. • When a whole house fan exhausts into the attic, both of the following must be completed: − Repair and seal ductwork in the attic − Repair and seal gaps/bypasses between the attic and living space (e.g., in the attic floor and knee walls) • Appliance enclosure door weatherstripping: Combustion air comes only from outdoors and interior combustion ventilation air vents are not present. • For attached garage: Door weatherstripping separates living space from garage when an open combustion appliance or any source of carbon monoxide (CO) is present. *Note: This list of sealing activities is not exhaustive. Other conditions may require occupant protection–related sealing.	• Appendix C Shell Leakage Testing Protocol

TABLE 32-1: PRIORITY LEVEL, SEALING ACTIVITY, AND INSTALLATION GUIDELINE DIRECTORY

PRIORITY 1: Catastrophic air leaks are present with a visible opening >5 sq. in.		
a. When measurable as a physical gap, a catastrophic shell leak is defined as 5 sq. in. of leakage calculated for a single measure location (e.g., a door, a window, etc.). b. To prove catastrophic shell leakage, measure and calculate gap length x gap width. If the total is equal to 5 sq. in. or more, then catastrophic leakage is justified. The actual calculation must be included in the CSD 540 Assessment Form, as in the example below. Example: 10" gap length x 0.5" gap width = 5 sq. in. This gap would qualify for repair as catastrophic leakage.		
Priority	**Sealing Activity**	**Installation Guideline Section**
Priority 1	• Missing interior vent covers	• Section 4 Heating and Cooling—Evaporative Coolers • Section 4 Heating and Cooling—Window/Wall Air Conditioners
	• Missing or broken attic or crawlspace access cover	• Access Hatches
	• Missing chimney damper or fireplace doors	• Fireplaces and Chimneys
	• Missing kitchen exhaust (KE) damper, or gaps around KE vent	• Section 11 Kitchen Exhaust
	• Window/Sliding Glass Door catastrophic leakage	• Window and SGD Repair • Note: Catastrophic window replacement is addressed in Section 33 Windows and Sliding Glass Doors
	• Door catastrophic leakage	• Doors
	• Other catastrophic leakage	• Shell Sealing • Note: Catastrophic duct sealing is addressed in Section 8 Ducting Repair, Sealing, and Insulation
	• Mobile home: Catastrophic leakage	• Mobile Home Sealing Activities

TABLE 32-1: PRIORITY LEVEL, SEALING ACTIVITY, AND INSTALLATION GUIDELINE DIRECTORY

PRIORITY 2: Attic and high-level air leaks are present		
Sources of infiltration at the ceiling level, or within 12" of the ceiling.		
Priority	**Sealing Activity**	**Installation Guideline Section**
Priority 2	• Sealing at top plate and sill plate	• Wall Bypasses
	• Defective attic or crawlspace access cover	• Shell Sealing
	• Framing gaps and wall cavity openings	• Wall Bypasses
	• Ceiling thermal bypasses	• Ceiling Bypasses
	• Duct penetrations and chaseways in the ceiling	• Penetrations
	• Electrical penetrations, i.e., gaps around electrical (junction) boxes or other ceiling penetrations	• Penetrations
	• Knee wall-to-ceiling gaps • Knee wall penetrations	• Ceiling Bypasses
	• Gaps around light enclosures	• Ceiling Bypasses
	• Mobile home	• Mobile Home Sealing Activities
PRIORITY 3: Crawlspace and low-level infiltration is present		
Sources of infiltration between the floor and foundation, or within 12" of the floor.		
Priority	**Sealing Activity**	**Installation Guideline Section**
Priority 3	• Bathtub holes and other plumbing penetrations	• Penetrations
	• Framing gaps and wall cavity openings	• Wall Bypasses
	• Duct penetration/chaseway in the floor	• Penetrations
	• Electrical penetrations at floor level	• Penetrations
	• Miscellaneous holes in flooring	• Crawlspace Bypasses
	• Mobile home: Bellyboard repair (All holes in the bellyboard created for underfloor access shall also be repaired.)	• Mobile Home Sealing Activities
PRIORITY 4: Interior/mid-level infiltration is present and has a visible opening >⅝"		
Sources of infiltration >⅝" in the shell that are more than 12" above the floor and 12" below the ceiling.		
Priority	**Sealing Activity**	**Installation Guideline Section**
Priority 4	• Gaps around kitchen exhaust vent (non-catastrophic)	• Section 11 Kitchen Exhaust
	• Plumbing penetrations under sinks in kitchens and bathrooms requiring a wall patch	• Penetrations
	• Electrical penetrations, including service panels on interior walls	• Penetrations
	• At washer hook-ups	• Penetrations
	• Envelope leaks requiring repair/patch	• Shell Sealing
	• Joints between dissimilar materials, especially around fireplaces and other masonry trim, large ceiling beams, tubs and showers	
	• Unfinished wall areas inside cabinets, penetrations under kitchen and bathroom sinks	
	• Mobile home: Gaps and holes in floors and walls, e.g., joints between halves of a mobile, a mobile and an “expando” unit or add-on room, etc.	• Mobile Home Sealing Activities

TABLE 32-1: PRIORITY LEVEL, SEALING ACTIVITY, AND INSTALLATION GUIDELINE DIRECTORY

PRIORITY 5: Interior/mid-level infiltration is occurring with a visible opening <⅝"		
Sources of infiltration ≤⅝" in the shell that are more than 12" above the floor and 12" below the ceiling.		
Priority	**Sealing Activity**	**Installation Guideline Section**
Priority 5	• Weatherstripping of attic/crawlspace access cover(s)	• Access Hatches
	• Hidden leaks behind appliances, especially washers and dryers, including dryer exhaust penetrations	• Wall Bypasses
	• Plumbing penetrations that can be caulked under sinks and in utility rooms	• Penetrations
	• Weatherstripping (doors/windows) between conditioned and unconditioned space	• Weatherstripping
	• Bypasses in walls, including cracks around molding/trim, etc.	• Wall Bypasses
	• Windows and leaks around window-mount appliances	• Window and SGD Repair
Priority 5 (cont.)	• Other infiltration points identified by blower door test or prescriptive sealing, including:	
	− Door or sliding glass door repair (with no catastrophic leakage)	• Doors • Window and SGD Repair
	− Window repair or glass replacement (e.g., cracked pane, up to five BB holes, etc.)	• Window and SGD Repair
	− Duct repair	• Section 8 Ducting Repair, Sealing, and Insulation
	• Cover plate gaskets	• Shell Sealing
	• Mobile home	• Mobile Home Sealing Activities
PRIORITY 6: Exterior infiltration is present		
Sources of infiltration in the home's exterior wall that allow infiltration into the wall cavities.		
Priority	**Sealing Activity**	**Installation Guideline Section**
Priority 6	• Exterior door and window frames, light fixtures, and holes in siding shall be sealed	• Shell Sealing
	• Mobile home	• Mobile Home Sealing Activities

4.4. Ceiling Bypasses

4.4.1 A ceiling bypass is a penetration from the living space into the attic (i.e., through the ceiling) that allows communication of conditioned air between the home and the attic.

4.4.2 Balloon Framing and Double Walls

4.4.2 (a1) Blocking shall prevent loose fill from falling down into open wall cavities.

4.4.2 (a2) The entire opening will be spanned with rigid material in line with the ceiling level.

4.4.2 (a3) The material will be cut to fit and mechanically fastened.

4.4.2 (a4) All remaining gaps at the top of the opening will be sealed.

4.4.2 (a5) All remaining gaps at the top of the chase will be sealed.

4.4.3 Open Combustion Furnace Vent

4.4.3(a1) Ceiling bypasses at vent penetrations shall be sealed only when:

- The bypass is not required for combustion air
- Installation of a metal collar does not cover a vented thimble or support system and does not violate local code

4.4.4 Closed Combustion Furnace Vent

4.4.4(a) Ceiling collar

4.4.4(a1) A vent (pipe) collar at the ceiling is not required for gaps <⅜". (The gap may be sealed with high-temperature caulk.)

4.4.4(a2) When no collar is present or gaps at the existing collar are ≥⅜", a metal collar shall be installed.

4.4.4(a3) Loose-hanging and fallen collars shall be reinstalled when feasible.

- Collars shall be sealed and mechanically secured against the ceiling (Fig. 32-1).
- Elastomeric caulk (or duct mastic) shall be applied to back side of the collar (high-temperature caulk within 3" of the flue pipe).
- The collar shall be secured with at least four anchors (e.g., sheet metal screws) which penetrate solid wood when possible.
- High-temperature caulk shall be used to seal gaps ≥1/16" between the pipe and collar.

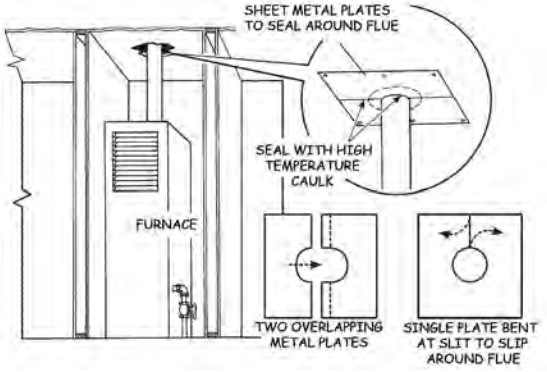


FIG. 32-1: SEAL CEILING VENT PIPES

4.4.5 Attic Penetrations

4.4.5(a) Heat-producing device (HPD) ceiling penetrations within the attic

4.4.5(a1) High-temperature caulk shall be used near HPDs (Fig. 32-2).

4.4.5(a2) Recessed lights

- Holes or ventilation openings in recessed light canisters or other HPDs shall not be blocked.

4.4.5(a3) Attic penetrations by masonry chimneys, see Fireplaces and Chimneys.

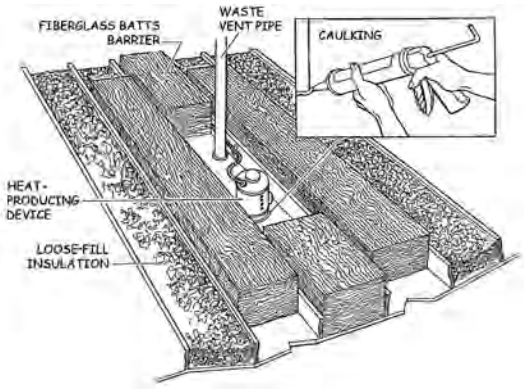


FIG. 32-2: USE HIGH-TEMPERATURE SEALANT ON HPDS

4.4.5(a4) Attic penetrations by metal pipes

- The following shall not be sealed:
  - Wall furnace vent pipes and other gas vents located inside wall cavities
  - Non-conforming single wall vent or flue pipes
  - Ventilated thimbles and collars

4.4.5(b) Ceiling vents not used for combustion air

4.4.5(b1) Seal the vent openings with minimum ½" gypsum, plywood, or metal and cover with insulation.

4.4.5(b2) Vents shall not be sealed with batts or foam board.

4.4.5(c) Non-HPD penetrations and similar leaks

4.4.5(c1) High-temperature caulk is not required for local or kitchen exhaust fan ducts, waste vent pipes, water pipes, and similar penetrations that are not heat-producing.

4.4.5(c2) Gaps <⅜" shall be sealed with elastomeric caulk.

4.4.5(c3) Gaps ≥⅜" shall be covered with a metal collar and:

- Sealed to the mounting surface with elastomeric caulk and
- Sealed at the penetration with elastomeric caulk

4.4.5(d) Chases and openings to the attic above a dropped ceiling or soffit

4.4.5(d1) The entire opening shall be spanned with rigid material in line with the ceiling level when possible or airflow will be blocked in locations where access allows.

4.4.5(d2) Material shall be cut to fit and fastened as required.

4.4.5(d3) Rigid material shall meet fire code flame and smoke spread requirements.

4.4.5(d4) All remaining gaps at the top of the chase/dropped ceiling shall be sealed.

4.4.5(d5) Tongue-and-groove ceilings

- Backing shall be installed behind tongue-and-groove ceilings.
- Sealants shall be compatible with their intended surfaces.
- Sealants shall be continuous and meet fire barrier specifications, according to the authority having jurisdiction.
- No sealant shall be allowed to be visible in the living space.

4.4.5(d6) Light boxes and fixtures in dropped ceilings (with non-intact fixed ceilings) or soffits

- An airtight seal shall be provided around perimeter between light box enclosure and interior ceiling.
- All seams and penetrations of the enclosure shall be sealed.
- Insulation shall be kept at least 3" away from the top and side of any fixtures.
- If a dropped ceiling will be filled with insulation, then a sealed rigid barrier enclosure shall be installed to maintain a 3" clearance on all sides and at least ½" from combustible materials.
  - Top of rigid barrier enclosure shall be sealed with non-insulating rigid material (e.g., gypsum or equivalent perm rating and R-value).

4.5. Crawlspace Bypasses

4.5.1 A crawlspace bypass is a penetration from the living space into the crawlspace (i.e., through the flooring) that allows communication of air from the crawlspace into the home's conditioned space (Fig. 32-3).

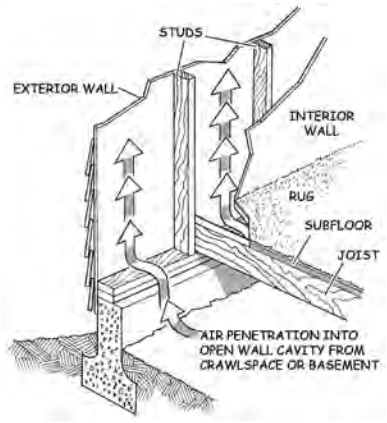


FIG. 32-3: CRAWLSPACE BYPASS

4.5.2 Preparation of Crawlspace for Sealing

4.5.2(a) Crawlspace repairs (sealing and installation of insulation) shall only be performed after heating, ventilation, and air conditioning work has been completed and inspected by the local jurisdiction.

4.5.2(b) When correction of standing water is not feasible, installation of floor insulation is not feasible.

4.5.2(c) When feasible, sealing of floor thermal bypasses shall be performed before floor insulation is installed.

4.5.2(d) Crawlspace must be separated from a conditioned basement or other conditioned space with a continuous air barrier, ground moisture barrier (when required by the local jurisdiction), and thermal boundary.

4.5.3 Balloon Framing and Double Walls

4.5.3(a) Blocking shall prevent loose fill from falling down into open wall cavities and into the crawlspace or basement.

4.5.3(b) The entire opening will be spanned with rigid material in line with the ceiling level.

4.5.3(c) The material will be cut to fit and mechanically fastened.

4.5.4 Bathtub Holes

4.5.4(a) The floor opening under a bathtub shall be sealed with filler board and sealant (Fig. 32-4).

4.5.4(a1) Radiant barrier, foam board, duct board, or other approved barrier material may be used for filler board.

4.5.4(a2) Silicone, acoustical caulk, or foam sealant may be used to seal filler board.

4.5.4(a3) Filler board shall be secured, as needed, with mechanical fasteners (screws, staples, or nails) to ensure a complete and permanent seal.

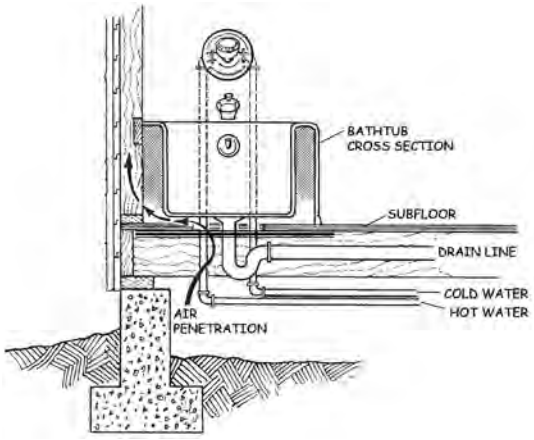


FIG. 32-4: OPENING UNDER BATHTUB

4.5.5 Other Floor Bypasses

4.5.5(a) Seal with caulk, foam, or other appropriate, approved material. (Also see Caulking.)

4.5.5(b) For plumbing floor penetrations, see Penetrations.

4.6. Doors

4.6.1 General Requirements

4.6.1(a) Documentation of the door repair or replacement condition is required.

4.6.1(a1) When catastrophic leakage is cited, measurements and calculations must be provided on the assessment form. (See Shell Sealing.)

4.6.1(b) Remove burs, sharp corners and edges, and other such hazards from the finished installation.

4.6.1(c) Modifying fire-rated doors

4.6.1(c1) Doors labeled to have a fire rating of >20 minutes shall not be modified or weatherstripped except as prescribed by the manufacturer and local code.

- Manufacturer or code documentation shall be kept in the client file.

4.6.2 Door Repair

4.6.2(a) Doors shall be repaired to correct infiltration or to support the installation of weatherstripping, safety glass replacement, etc.

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

4.6.2(c) Sealing wood components

4.6.2(c1) New wood components shall be sealed on both sides and four edges with exterior-grade sealant.

- Acceptable exterior-grade sealers are paint, urethane, and varnish.
- Clear “water seal” products are not allowed.

4.6.2(d) Hardware shall be installed per manufacturer’s instructions.

4.6.2(e) Safety glass repair

4.6.2(e1) Safety glass is required in door inserts.

4.6.2(e2) Replacement of existing in-door glazing with a “like” specialty glass (e.g., stained glass or special design glass) is not allowed.

4.6.2 (e3) When allowed by local code and with permission of the client, polycarbonate may be used instead of tempered glass.

4.6.2 (f) Door fit repair

4.6.2 (f1) When the door does not close properly due to incorrect sizing or changes to door jamb shape, the door shall be planed or trimmed to improve closure and reduce infiltration.

4.6.2 (g) Doorstop repair

4.6.2 (g1) Wood jambs (Fig. 32-5)

- Stops shall be made of wood.
- Minimum stop dimensions: 5/16" x 1¼"

4.6.2 (g2) Stops shall not be doubled (one on top of another) for added thickness on the latch side.

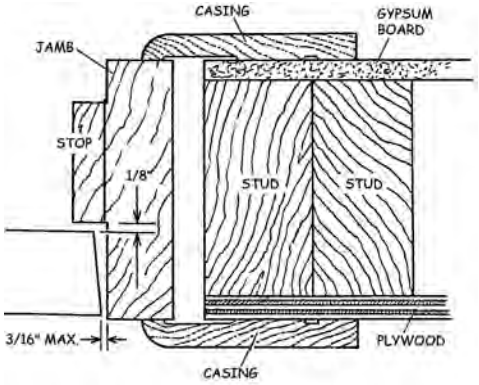


Fig. 32-5: Door Jamb Diagram

4.6.2 (h) Casing/trim repair

4.6.2 (h1) Exterior-grade wood is required in all exterior locations.

- Paint-grade wood is acceptable if the wood does not have a natural finish.

4.6.2 (h2) New casing/trim size/shape and miters shall be compatible with existing casing/trim visible from the location of the door.

4.6.2 (h3) Sealer or primer shall be installed to prevent moisture damage to unfinished wood. (See Sealing wood components.)

4.6.2 (h4) Finishing or casing nails are required for interior applications.

4.6.2 (h5) Galvanized nails are required for exterior applications.

4.6.2 (h6) Exterior casing/trim shall be caulked to provide a watertight seal around the entire perimeter.

4.6.2 (h7) Exterior and interior gaps and cracks shall be caulked in accordance with Caulking.

4.6.2 (i) Door jamb repair

4.6.2 (i1) Exterior-grade material only

4.6.2 (i2) 1¼"-thick stock standard; ¾" minimum

4.6.2 (i3) Width shall be within ¼" of the finished wall thickness.

4.6.2 (i4) The top shall be secured to the sides with dado or rabbet joints.

4.6.2 (j) Threshold repair

4.6.2 (j1) See Thresholds.

4.6.2 (k) Door hinge repair

4.6.2 (k1) Brass or stainless-steel flathead jamb screws shall be used for hinge repair with wood and metal jambs or as specified/supplied by manufacturer.

4.6.2 (k2) Existing screw holes shall be filled with plugs or wooden golf tees and glued before reuse unless larger/longer screws that tighten securely are installed.

4.6.2 (k3) Hinge relief mortise and flush mounting are required for all hinges. Mortise holes abandoned due to hinge relocation shall be patched.

4.6.2 (k4) Screws shall penetrate the trimmer stud at least ⅝".

4.6.2 (l) Deadbolts

4.6.2 (l1) Deadbolts shall turn freely and engage when the door is closed and the entry set latch tongue is inside the strike plate.

4.6.2 (m) Strike plate

4.6.2 (m1) A jamb strike plate is required.

4.6.2(m2) The latch tongue shall engage properly when the door is closed with normal force.

4.6.2(m3) Simple strike plate adjustments shall not be billed as door repair.

4.6.2(m4) Multiple strike plates for added thickness are not allowed.

4.6.2(m5) The jamb shall be repaired when the latch will not function properly with one strike plate.

4.6.2(m6) When existing holes will not properly secure a standard strike plate:

- The jamb shall be repaired, or
- A large-sized strike plate (e.g., 4⅞" x 1¼") shall be installed to replace a standard plate when the screw holes in the jamb are stripped

4.6.2(n) Finish/sealer for exterior doors (Fig. 32-6)

4.6.2(n1) Doors, including those that are cut to fit on-site, shall be sealed (painted or primed) to prevent moisture intrusion.

4.6.2(n2) Acceptable sealers for wood doors, jamb, and casing/trim are exterior-grade paint, urethane, and varnish.

4.6.2(n3) Acceptable sealer for metal doors is exterior-grade paint.

4.6.2(n4) Clear “water seal” products are not allowed.

FIG. 32-6: DOOR FINISH SEALER

4.6.3 Door Installation

4.6.3(a) If both a new door blank and hardware (latch, door bottom, etc.) are installed, the work is door replacement.

4.6.3(b) All hinged replacement doors shall be:

4.6.3(b1) Limited to entrance doors and interior and exterior appliance enclosure doors

4.6.3(b2) Equipped with a keyed locking mechanism

4.6.3(b3) Glazed with safety glass

4.6.3(c) Locks and deadbolts

4.6.3(c1) Existing locks and deadbolts shall be reused if they are functional.

- Exception: If the existing deadbolt has a key closure on the interior side, it shall not be installed in the replacement door.

4.6.3(c2) New deadbolts shall have a thumb turn on the interior side.

4.6.3(c3) In renter-occupied dwellings, installation of a new deadbolt is only allowed when:

- A new replacement door is being installed, and
- The old deadbolt is inoperable or is not present

4.6.3(c4) In owner-occupied dwellings, a new deadbolt is not allowed when a door is being replaced; however, an existing deadbolt may be installed in the replacement door.

4.6.3(c5) When multiple new locks or deadbolts are installed, the new locks shall all be keyed alike.

4.6.3(c6) Existing locks shall not be re-keyed to match new locks.

4.6.3(d) All replacement doors shall:

4.6.3(d1) Be sized to fit properly into the opening with clearances that meet the door manufacturer’s specifications

4.6.3(d2) Be framed square, level, and plumb in the opening

4.6.3(d3) Match the style of the existing door, subject to local code requirements

4.6.3(e) Entrance doors

4.6.3(e1) Replacement doors shall be limited to standard solid core slab or panel doors. (No ornate design, stained glass, decorative windows, etc., is allowed unless required by the State Historical Preservation Office and approved by weatherization waiver.)

4.6.3(e2) Entrance doors shall be fire-rated to comply with local code (e.g., from living area to garage in homes with attached garage, and in multi-family units).

4.6.3(e3) Securely attach the hinge side to the structural framing.

4.6.3(e4) Install mineral fiber or backer rod insulation in gaps between the door frame and the rough opening.

- Injected foam is not allowed.

4.6.3(e5) Caulk the exterior casing/trim to provide a watertight seal around the entire perimeter.

4.6.3(e6) Integral or applied weatherstripping is required.

4.6.3(e7) Shims shall not extend the top of the threshold above the finished floor by more than 1", or by more than ½" if any occupant is physically handicapped.

4.6.3(e8) Warpage for all doors shall not exceed ½" from end to end, to facilitate proper weatherization (Fig. 32-7).

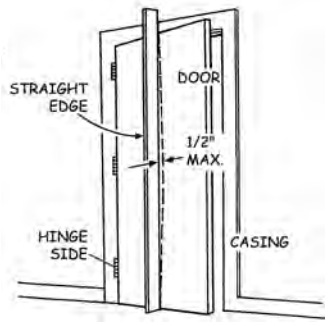


FIG. 32-7: WARPAGE LIMITS

4.6.3(f) Entrance door hinge requirements

4.6.3(f1) At least three hinges per door are required.

4.6.3(f2) Hinges must be loose-pin type unless mounted toward the exterior.

4.6.3(f3) At least one spring-loaded hinge is required when the door is between an attached garage and a living area.

4.6.3(f4) A hinge relief mortise and flush mounting are required for all hinges.

4.6.3(f5) Patch any mortise holes abandoned due to hinge relocation.

4.6.3(f6) Existing hinge screw holes may be used if standard or larger/longer screws tighten the hinge securely. If not, the holes may be filled with plugs or wooden golf tees and glued before reuse.

4.6.3(f7) Hinge screws must penetrate the trimmer stud at least ⅝".

4.6.3(g) Entrance door clearances

4.6.3(g1) Door face to doorstop: Maximum clearance of ⅛" when the entry set latch tongue and strike plate are engaged.

4.6.3(g2) Door edge to door jamb: The distance between the door edge and jamb (when the door is closed) shall be minimum ⅛" and maximum 3/16".

4.6.3(h) Entrance door locks

4.6.3(h1) Ensure the entrance lockset height is 36" from the floor when both the door and the jamb are replaced.

- The lockset may remain at its existing height when only the door blank is replaced.

4.6.3(h2) The deadbolt shall:

- Turn freely and engage when the door is closed and the entry set latch tongue is inside the strike plate
- Have a thumb turn on the interior side. (An inside key is not allowed.)

4.6.3(h3) A strike plate is required and will latch the entry set tongue when the door is closed with normal force.

- Multiple strike plates are not allowed.
- When the latch will not function properly with one strike plate:
  - Repair the jamb or
  - Install a longer, heavy-duty strike plate with new screw holes

4.6.3(i) Entrance door thresholds

4.6.3(i1) See Thresholds.

4.6.3(j) Sealing entrance doors

4.6.3(j1) Seal all bare wood (doors, jambs, and casing/trim) with exterior-grade paint, urethane, or varnish.

- Clear “water seal” products are not allowed.

4.6.3(j2) Seal wood doors on both sides and on four edges.

4.6.3(j3) Paint or prime metal doors with oil-based or epoxy paint only.

4.6.3(k) Entrance door trimming/modifications

4.6.3(k1) For veneer-type (not solid) replacement doors, a maximum of 1" may be cut from the sides and top and a maximum of 2" may be cut from the bottom unless the door has expanded rails and stiles and/or deeper cutting is approved by the door manufacturer.

4.6.3(k2) Doors labeled with a fire rating of >20 minutes shall not be modified or weatherstripped except as prescribed by the manufacturer and local code.

- Documentation of the above manufacturer specifications shall be kept in the client file.

4.6.3(k3) A 3°–5° bevel is required on the lockset edge.

4.6.3(l) Appliance enclosure doors

4.6.3(l1) Health and Safety (H&S) Support: Repair or installation of an appliance enclosure door (for an H&S appliance) that is missing, does not close properly, allows entry of combustion byproducts into the living space, or allows entry of inclement weather into the enclosure, per Section 1 General Installation Guidelines, Limited Home Repair.

4.6.3(l2) Energy Conservation Measure (ECM) Support: Repair or installation of an appliance enclosure door (for an ECM appliance) that is missing, does not close properly, allows entry of combustion byproducts into the living space, or allows entry of inclement weather into the enclosure, per Section 1 General Installation Guidelines, Limited Home Repair.

4.6.3(l3) Exterior

- Installation requirements for exterior appliance enclosure doors are the same as those for entrance doors except the door must be exterior-grade solid slab or metal-clad only.

4.6.3(l4) Interior

- Seal interior wooden doors on both sides and on four edges with interior-grade primer, paint, urethane, or varnish.
  - Clear “water seal” products are not allowed.
- Install jamb screws that penetrate the trimmer stud at least ⅝" on pre-hung units and replacement jambs.
- Install the interior door lock/latch in accordance with entrance door lock requirements in Locks and deadbolts.
- Patch any mortise holes abandoned due to hinge relocation.
- Hinge relief mortise and flush mounting is required for all hinges.
- Existing hinge screw holes may be used if standard or larger/longer screws tighten the hinge securely. If not, the holes may be filled with plugs or wooden golf tees and glued before reuse.
- Hinge screws must penetrate the trimmer stud at least ⅝".
- See Appendix A Combustion Appliance Safety Protocol for additional information about combustion ventilation air (CVA).

4.6.3(m) Thresholds

4.6.3(m1) Door bottom and threshold weatherstripping

- A gasketed metal U-shoe and metal or wooden saddle threshold combination is used whenever possible (Fig. 32-8).

- A gasketed door shoe can be installed without a new threshold if the shoe seals properly against the existing threshold.
- Use a high-profile, U-type door shoe (e.g., 3"-high U, kick plate–style) when door bottom is cut too short or is too worn/weak to accept a standard (1½"-high) U-shoe.
- An L-shoe is allowed only when a U-shoe cannot be installed, (e.g., due to non-standard door thickness).

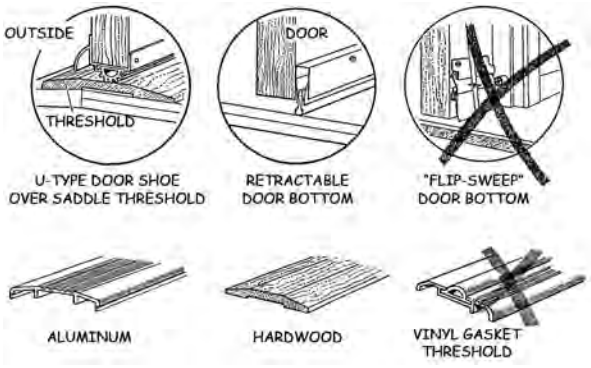


Fig. 32-8: Weatherstripping Door Bottoms and Thresholds

- A plastic unit may be used when an aluminum carrier will not fit and the door cannot be cut.
- Install a stationary sweep only when the use of a door shoe/threshold combination is not feasible.
- Automatic door bottoms are used only when a shoe/threshold combination is not feasible or a stationary sweep is not feasible due to drag on the floor surface.
- A bumper threshold is the best option for an appliance enclosure or out-swinging garage door.
- Weatherstripping material shall not drag on the floor covering (wood, tile, carpet, etc.).

4.6.3(m2)

Threshold height

- The threshold, and riser when present, shall extend a maximum of 1" above the interior finished floor, or a maximum of ½" above the interior finished floor when any occupant uses a wheelchair or walker) (Fig. 32-9).
- A low-profile threshold (e.g., ¼" high) may be installed to minimize height.
- Threshold risers and elevators/shims (Fig. 32-10)

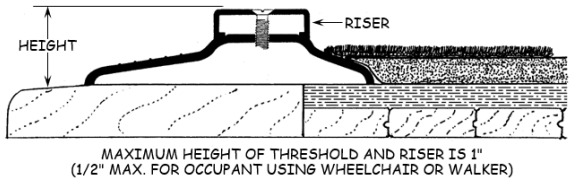


Fig. 32-9: Threshold Repair

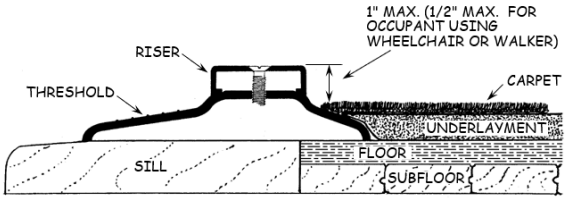


Fig. 32-10: Threshold Riser

  - A threshold riser may be used to increase height.
  - When a riser is installed on top of an existing threshold:
    - It shall be installed full-length; splicing is not allowed
    - Riser material must be the same as the threshold material (aluminum or hardwood)
  - Field-fabricated risers, when allowed, shall:
    - Be made of solid stock that is 80–100% of the width of the top surface and has evenly rounded or beveled top edges
    - Be securely attached with four countersunk screws located within 3" of each end and equally spaced in the field

- Threshold elevators/shims
  - All elevators/shims shall be:
    - A solid block of decay-resistant wood (e.g., cedar, redwood, white oak)
    - Installed securely under the threshold and trimmed to conform to the footprint of the threshold

4.6.3(m3) Saddle threshold installation (Fig. 32-11):

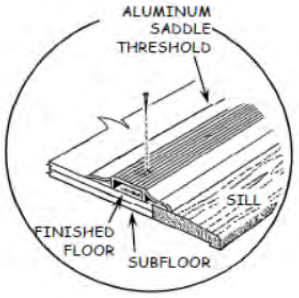


FIG. 32-11: SADDLE THRESHOLD

- A saddle threshold shall be installed where possible.
- The threshold shall be installed full-length; splicing is not allowed.
- The ends of the threshold shall be cut to match the contour of the jamb (i.e., notched to fit snugly around the jamb, stop, trim, etc.).
- The threshold perimeter shall be sealed (e.g., by caulking the ends and, when floor sealer gaskets do not completely seal, the front and back edges).
- Wooden thresholds
  - The threshold shall be sealed to the floor with glue, or elastomeric caulk, or floor-sealer gaskets.
  - The threshold shall be mechanically secured with countersunk nails or screws.
  - Nail holes shall be filled with exterior-grade filler/putty.
- Metal thresholds
  - The threshold shall have floor-sealer gaskets in place.
  - The threshold shall be permanently screwed in place.

4.7. Shell Sealing

4.7.1 General Requirements

4.7.1(a) Cracks and gaps in the envelope shall be sealed from the interior side whenever feasible.

4.7.1(b) A continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections.

4.7.1(c) Sealants shall be compatible with their intended surfaces.

4.7.1(d) Sealants shall be continuous and meet fire barrier specifications according to the authority having jurisdiction.

4.7.1(e) No sealant shall be allowed to be visible in the living space.

4.7.1(f) Underwriters Laboratories (UL) 181 metallic tape shall not be used for any shell sealing purpose in any location (exposed or non-visible).

4.7.1(g) When a supplemental barrier is created (e.g., with a collar), it shall be secured as needed with mechanical fasteners (screws, staples, or nails) to ensure a complete and permanent seal.

4.7.1(h) When applicable, sealing material shall be evenly tooled with excess material removed to ensure a clean appearance and adequate seal.

4.7.1(i) Cracks and gaps ≤⅝" wide shall be caulked in accordance with Caulking.

4.7.1(j) Gaps >⅝" shall be sealed with barrier material and/or filler board and sealants as described in Patching.

4.7.2 House-Garage Separation

4.7.2(a) All cracks in the house and garage separation wall will be sealed, including cracks between the bottom of gypsum board and the mud sill, rim joists, and subfloors.

4.7.2(a1) When sealing from the interior side is not feasible, seal from the garage side.

4.7.3 Caulking

4.7.3(a) General requirements

4.7.3(a1) Note: Exterior caulking is not required above the first floor.

4.7.3(b) Follow the manufacturer's instructions, with careful attention to:

4.7.3(b1) Surface preparation

4.7.3(b2) Primer requirements (especially for metal and masonry surfaces)

4.7.3(b3) The use of filler material (e.g., backer rod) and/or bond breaker tape

4.7.3(b4) The width and depth of the bead

4.7.3(b5) The proper sealant application method

4.7.3(b6) Tooling recommendations

4.7.3(c) Surface preparation

4.7.3(c1) The surface will be free of:

- Loose or cracked caulking
- Dirt, debris, and oily substances
- Moisture, unless allowed by the manufacturer's specifications

4.7.3(d) Visible interior locations

4.7.3(d1) Caulk must be:

- Clear when dry, or color-coordinated with the surrounding material and existing caulk
- Paintable with the following exceptions:
  - Polyurethane (paintable) caulk is mandatory in visible locations where elastomeric sealant is required.
  - Silicone may be used with joints between dissimilar materials when that is the best option (e.g., when sealing around the perimeter of a window-mount air conditioner).

4.7.3(d2) Foam sealant may be used to seal large gaps in penetrations (e.g. plumbing and electrical) in accordance with Patching.

4.7.3(e) Non-visible interior locations

4.7.3(e1) Pipe penetrations under sinks will be sealed behind escutcheons when possible.

- In inaccessible, non-visible locations only, where installation of caulking and a metal escutcheon is impossible, sealing may be performed using butyl foil tape or adhesive floor/plumbing patches.

4.7.3(e2) Cracks and holes in appliance enclosure walls and exhaust duct penetrations will be caulked when possible or repaired/patched:

- From the living space side when feasible
- From inside the furnace and water heater enclosures where products of combustion could leak into the living space
- Around the exhaust fan duct penetration of (e.g., the range hood duct through the ceiling)

4.7.3(f) Exterior caulking

4.7.3(f1) For large gaps between the siding and the door or window casings in lap-sided homes, caulk:

- At door thresholds
- All three legs of the doorstops
- The junction of the door jamb and the casing

4.7.3(f2) For masonry, metal joints, and joints between two different materials (Fig. 32-12), use:

- Elastomeric caulk or
- Masonry caulk with a neutral cure (e.g., oxime cure) or

- Paintable silicone

4.7.3(f3) In attics and crawlspaces, foam sealant will be used in accordance with manufacturer's specifications unless prohibited by local code.

4.7.3(f4) Wood joints require elastomeric or butyl caulk.

4.7.3(g) Use backing or infill as needed to meet the specific characteristics of the sealant and the gap being filled.

FIG. 32-12: ELASTOMERIC CAULK FOR MASONRY, METAL, AND DISSIMILAR JOINTS

4.7.3(g1) The backing or infill must not bend, sag, or move once installed.

4.7.3(g2) Acceptable filler materials include:

- Closed-cell polyethylene backer rod
- Flexible fiberglass
- Rope caulk

4.7.3(g3) Acceptable bond breakers

- Polypropylene, polyethylene, polytetrafluoroethylene (PTFE), or closed-cell foam self-adhesive bond breaker tape

4.7.3(h) Cracks at least 1⁄16" wide and no larger than 5⁄8" wide require caulking.

4.7.3(h1) Gaps ≤3⁄8" will be caulked with any material approved for the location and the type of joint.

4.7.3(h2) Gaps 7⁄16"–5⁄8" will be caulked with silicone, polyurethane, or acrylic latex.

4.7.3(h3) Additional requirements for large gaps:

- For gaps 3⁄8"–5⁄8", insert backer material to within 1⁄2" of the surface before caulking.
- For gaps >5⁄8", see Patching.

4.7.3(i) Quality of the finished bead

4.7.3(i1) On all joints:

- The bead will be:
  - The minimum size required to achieve a permanent seal
  - Continuous and free of voids and bubbles
  - Applied/tooled with sufficient pressure to fill the joint completely
- Remove excess caulk.

4.7.3(i2) On butt joints (Fig. 32-13):

- The bead will be at least 1⁄8" deep, but no deeper than it is wide
- The depth will be controlled by filler material (e.g., foam backer rod)
- The bead will be tooled to:
  - Compress the sealant against the filler material and sides of the joint
  - Remove excess caulk
  - Form a concave surface (e.g., create an "hourglass" profile when backer rod is used)
- When filler material is not used and a bond breaker is recommended by sealant manufacturer, bond breaker tape will be installed to prevent sealant adhesion to the bottom of the joint.

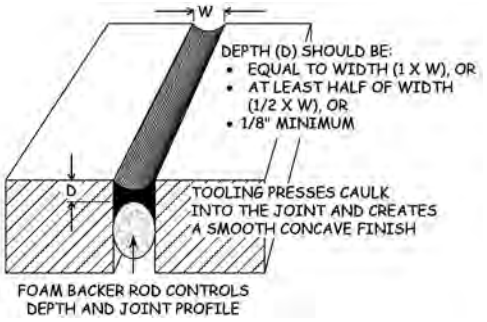


FIG. 32-13: A HIGH-QUALITY FINISHED BEAD

4.7.3(j) Heat-producing devices (HPDs)

4.7.3(j1) High-temperature sealant must be used around all HPDs (Fig. 32-2).

4.7.3(j2) Recessed lights:

- Ensure the vent holes in the recessed light canister are not sealed.

4.7.3(k) Do not apply caulk to decorative trim.

4.7.4 Patching

4.7.4(a) Wall (drywall) patches

4.7.4(a1) Factory-made mesh patches

- Finish the patch to match the surrounding surface (e.g., with mesh covered by at least two coats of drywall mud sanded between each coat or with light-weight spackle).

4.7.4(a2) Field-fabricated patches for large holes (Fig. 32-14)

- Field-fabricate the patch using a piece of drywall that matches the thickness of the drywall covering the wall (or ceiling).
- Patches shall be:
  - Beveled to fit securely in the hole or
  - Supported by backer boards screwed to the wall inside the hole
- Gaps between the patch and wallboard shall be filled (e.g., with drywall mesh and mud).
- The patch shall be finished to match the surrounding surface (e.g., with drywall mesh covered by at least two coats of drywall mud sanded between coats).
- Patches in exposed locations (not inside a cabinet) shall be sealed with primer and/or paint to prevent moisture intrusion.

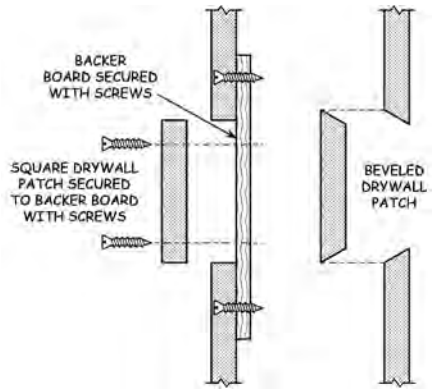


FIG. 32-14: FIELD-FABRICATED PATCHES

4.7.4(b) Foam sealants and foam board—Interior locations

4.7.4(b1) Plumbing/electrical penetrations and other bypasses

- Foam sealant may be used to seal gaps, subject to the following limitations:
  - Gap size, location, and conformance with foam manufacturer's specifications and local code.
- Finished foam sealant
  - The foam surface shall be even with the surrounding surface.
  - When an escutcheon is present, it shall be placed over the finished foam sealant.

4.7.4(b2) Foam board

- Foam insulation board shall not be installed to patch the interior of a dwelling (including attached room(s) or garage).

4.7.5 Access Hatches

4.7.5(a) The hatch material shall create a full seal with no gaps or openings to the framing.

4.7.5(a1) Finishing materials shall be installed in accordance with the manufacturer's instructions.

4.7.5(a2) Sealing materials shall be evenly tooled with excess material removed to ensure a clean appearance and adequate seal.

4.7.5(b) All hatches—Weatherstripping and insulation

4.7.5(b1) Weatherstripping and insulation are required only when the access is located between a conditioned and an unconditioned space.

4.7.5(b2) The access shall be weatherstripped as prescribed in Weatherstripping.

4.7.5(b3) Flexible or rigid insulation with an R-value equal to the attic floor shall be attached to the cover in accordance with Section 37 Attic and Ceiling Insulation.

4.7.5(c) Attic access (replacement of missing and/or broken cover)

4.7.5(c1) The cover material shall be sized to fit the rough opening, with gaps along edges not to exceed ¼" per side.

4.7.5(d) Attic access (New installation—Horizontal)

4.7.5(d1) The rough opening size and location shall be:

- At least 22" x 30"
- Where unobstructed headroom at some point above the access is at least 30" measured vertically from the bottom of ceiling joists

4.7.5(d2) Cutting the opening

- Cuts shall be located along the edges of the ceiling joists.
- Ceiling material shall be cut out neatly and set aside for use as the access cover.

4.7.5(d3) Blocking the opening

- The rough opening of the attic hatch will be surrounded with a durable, rigid, protective baffle that is higher than the level of the surrounding attic floor insulation to achieve uniform R-value on the attic floor and prevent loose attic floor insulation from entering the living area.
- Blocks shall be:
  - Cut to fully extend from joist to joist
  - Placed perpendicular to the joists at the edges of the opening

4.7.5(d4) Anchors

- Blocks shall be secured (anchored) at each end with minimum 3" nails or comparable screws driven through the joists.
- Minimum two anchors for 2" x 4" and three anchors for 2" x 6".

4.7.5(d5) Cutting a ceiling joist

- If removal of part of an obstructing joist is absolutely necessary:
  - Cut-off joist ends shall be supported with blocks (framing) installed across the ends and secured to the adjacent joists
  - Framing shall be secured with minimum 3" nails or comparable screws driven through the joists at each end of the joist, and through the block into the cut-off joist
  - Use a minimum of two anchors for 2" x 4" and three anchors for 2" x 6", or as required by local code
  - Cutting and blocking the cut joist shall not violate local code

4.7.5(d6) Securing the ceiling

- Blocks shall be installed against the ceiling.
- The ceiling material shall be secured to the blocks with anchors (e.g., drywall nails or screws) that penetrate the blocks at least ½".
- Anchors shall be located at each corner of the opening and at intervals not exceeding 6".

4.7.5(d7) Access cover

- The cover shall be sized to fit the rough opening with gaps along edges not to exceed ¼" per side.

4.7.5(d8) Installing trim:

- Trim/molding shall:
  - Be cut with mitered corners
  - Extend into the opening at least ⅝"

  - Positioned so nails will penetrate framing at least ⅝"
- Trim/molding shall be secured with finish nails.
  - Countersunk nails shall be at each corner and spaced at intervals not exceeding 6".
  - Nail holes shall be filled with spackle or wood putty (not caulk).

4.7.5(d9) Finishing:

- Bare wood shall be primed or painted.

4.7.5(e) Attic access (New installation—Vertical)

4.7.5(e1) Knee wall

- Access shall be installed between two knee wall studs.
- Minimum 22" x 30", or as wide as possible when studs are <24" on center (OC).

4.7.5(e2) Cutting the opening

- Cuts shall be located along the edges of the knee wall studs.
- Wall material shall be cut out neatly and carefully and set aside if it will be incorporated into the access cover.

4.7.5(e3) Access cover/door

- If any framing is required to complete the opening (e.g., a block between studs), it shall match the dimensions of the studs.

4.7.5(e4) Installing hinges

- Spring-loaded hinges shall be required when the access penetrates a firewall.
- Standard and spring-loaded hinges shall properly support the access door and make it self-closing in accordance with the following guidelines:
  - One spring hinge for doors weighing ≤45 lbs.
  - Two spring hinges for doors weighing ≤75 lbs.
  - Three spring hinges for doors weighing ≤90 lbs.
- The hinges shall be attached to a stud and to plywood backing (not to gypsum).
- Screws shall penetrate the wood at least ½".

4.7.5(e5) Installing trim

- Trim/molding shall be:
  - Cut with mitered corners
  - Positioned so the nails will penetrate the framing at least ⅝"
- Trim/molding shall be secured with finish nails
  - Countersunk nails shall be at each corner and spaced at intervals not exceeding 12".
  - Nail holes shall be filled with spackle or wood putty (not caulk).

4.7.5(e6) Finishing and latch

- At a minimum, bare wood shall be primed.
- A latch shall be installed that pulls the door tightly against the frame and weatherstripping.

4.7.5(f) Crawlspace access cover replacement—Horizontal

4.7.5(f1) Framed opening

- The ends of the opening shall be framed with blocks that are perpendicular to the floor joists at the edges of the opening and fully extend from joist to joist.
- The blocks shall be properly secured at each end to the floor joists (e.g., with minimum 3" nails or comparable screws, minimum two anchors for 2x4, and three anchors for 2x6).

4.7.5(f2) Access cover

- Deteriorated/defective cover(s) shall be repaired with new materials comparable to those used for the existing cover and surrounding floor.
- Installed hardwood or other finish material shall be attached with finish nails.
- Finish nails shall be countersunk, and the holes shall be filled with wood putty.
- Finish surface
  - The top of the access cover shall be:
    - Flush with the floor when the top surface is flooring, or it will be covered by carpet or other floor covering
    - Recessed appropriately, if needed, to accommodate the future installation of finishing material (e.g., hardwood)

4.7.5(g) Crawlspace access cover—Vertical

4.7.5(g1) Access location

- Due to the complexity of this work, installation shall require prior approval from CSD.
- Cuts/alterations in a foundation wall shall not violate local code.
- Best practice
  - Minimum 16" x 24" opening (per code) or as wide as feasible
  - Located where crawl clearance is ≥18"

4.7.5(g2) Access cover

- New corrosion-resistant screened metal or solid metal material shall be installed per manufacturer's instructions.
- Metal framing shall be secured to:
  - Wood with corrosion-resistant screws that penetrate at least ½"
  - Concrete with corrosion-resistant screws and compression anchors
- Wood framing (box frame)
  - Framed wood (plywood or 1-by boards) shall be:
    - 1x2 redwood or pressure-treated fir at a minimum
    - Attached to concrete with concrete nails or corrosion-resistant screws and compression anchors
    - Attached to wood with nails or screws that penetrate solid wood at least ½"
- Hinges and latches
  - Hinges and/or latches, when applicable, shall be installed with corrosion-resistant anchors.
- Finishing
  - At minimum, bare wood shall be primed.
- Insulation
  - Not applicable (unconditioned space is on both sides of the access cover).

4.8. Fireplaces and Chimneys

4.8.1 Masonry Chimneys

4.8.1(a) Attic penetrations by masonry chimneys

4.8.1(a1) Seal penetrations with a non-combustible barrier and high-temperature sealant.

- Galvanized sheet metal or aluminum shall be a minimum of 0.007" thick.
- Barrier shall be mechanically secured to ensure permanent installation.

4.8.2 Fireplace Chimney Dampers

4.8.2(a) Factory-built ("zero clearance") fireplaces

4.8.2(a1) Malfunctioning dampers shall be repaired or replaced with listed parts specified by the manufacturer.

4.8.2(b) Masonry fireplaces

4.8.2(b1) Malfunctioning dampers shall be repaired.

4.8.2(b2) A retrofit damper shall be installed when no damper is present or repair of a malfunctioning damper is not feasible.

4.8.2(b3) Retrofit dampers

- Only commercially available top-sealing dampers shall be used for retrofitting. (See Appendix A Combustion Appliance Safety Protocol, Table 14.4.1, Gas log.)
- The damper shall be properly sized to fit the chimney termination.

4.8.2(b4) When replacing a damper, a spark arrestor shall be present or installed. (See Section 1 Limited Home Repair (LHR) Policy and Appendix A Combustion Appliance Safety Protocol.)

4.8.2(c) Gas log

4.8.2(c1) When a gas log is present, the damper shall be blocked partially open (e.g., by means of a permanently installed damper clamp).

4.8.2(c2) When a permanent opening is not feasible, damper installation is not feasible and the house is NIM.

4.8.2(c3) California Mechanical Code (CMC) sizing and clamp policies shall apply.

- The fireplace shall have a permanent free opening based on the appliance input rating and chimney height.
- Shell sealing is not feasible if the damper does not have a permanent free opening (provided by a damper clamp or other means).

4.8.3 Fireplace Glass Doors

4.8.3(a) All fireplaces

4.8.3(a1) All pre-existing fireplace glass door units shall seal against the fireplace surround (the surface surrounding the fireplace opening).

4.8.3(b) Retrofit glass doors

4.8.3(b1) When a fireplace damper is not present or is not feasible to install, glass doors for fireplaces shall be selected and installed.

4.8.3(b2) The glass door unit shall be designed and sized to fit:

- The smallest dimensions of the firebox opening
- The surround size and surface (smooth or textured)

4.8.3(c) Attachment of the glass door unit (Fig. 32-15)

4.8.3(c1) The top of the door unit shall be mechanically secured to the lintel bar (e.g., with a lintel clamp).

4.8.3(c2) The bottom shall be attached to the firebox floor.

4.8.3(c3) Insulation or gasketing applied to the back of the glass door unit shall create a tight seal at the surround.

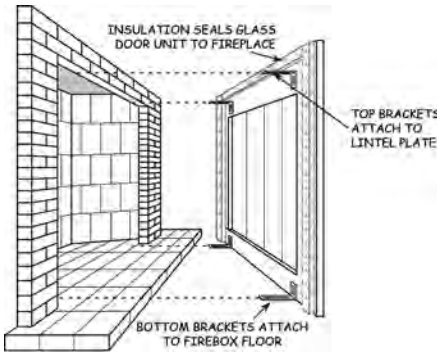


FIG. 32-15: ATTACHING GLASS DOOR UNITS

4.9. Penetrations

4.9.1 All lighting fixtures, wiring, plumbing, venting, ducting, and gas piping penetrations will be sealed.

4.9.2 Patching of Penetrations

4.9.2(a) Gaps over ⅝" wide shall be covered with a sheet metal collar or mesh plumbing patch that is sealed and secured.

4.9.2(a1) A metal collar may be fabricated using one or two pieces of galvanized sheet metal or aluminum notched (cut out) to fit around the penetration or

4.9.2(a2) Commercially available plumbing patches and pipe collars shall be used

4.9.2(b) Use caulk or other sealants/patches in accordance with Shell Sealing, Caulking and Patching.

4.9.3 Installation of a Field-Fabricated Metal Collar (Fig. 32-16)

4.9.3(a) Required on wall or floor penetration, including on floors in exposed locations (i.e., not inside a cabinet)

4.9.3(a1) Apply sealant (e.g., elastomeric) to the back side.

4.9.3(a2) Press the patch/collar into place and secure each separate piece with at least two anchors (e.g., sheet metal screws) that penetrate solid wood where possible.

4.9.3(a3) Remaining gaps ≥1⁄16" shall also be caulked.

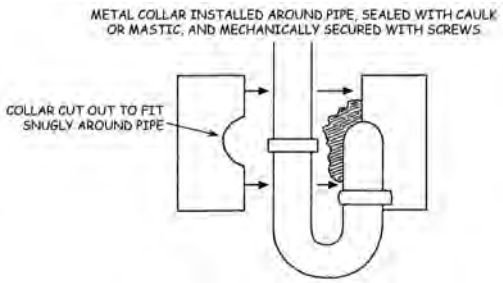


Fig. 32-16: Metal Collar

4.9.4 Installation of Mesh Plumbing Patch (Fig. 32-17)

4.9.4(a) Surfaces shall be free of:

4.9.4(a1) Loose or cracked caulking or patching material

4.9.4(a2) Loose drywall material, dirt, debris, and oily substances

4.9.4(a3) Moisture

4.9.4(b) Patches shall be 28–30-gauge non-corrosive metal with strong self-adhesive backing.

4.9.4(c) Backing shall be reinforced with fiberglass mesh or equivalent.

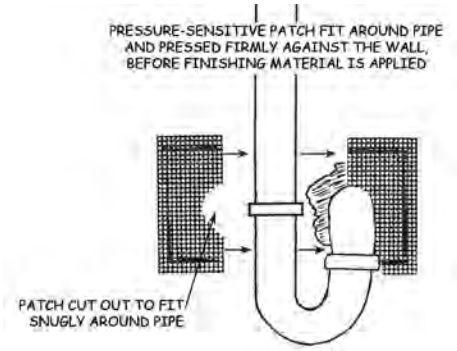


Fig. 32-17: Mesh Plumbing Patch

4.9.4(d) Patches shall be cut to fit snugly around pipes (e.g., pre-cut for installation around 2", 1½", ¾", and ½" pipes).

4.9.4(e) Firm pressure shall be applied to the adhesive to eliminate gaps along edges.

4.9.4(f) The patch shall be sealed to the mounting surface along the entire perimeter of the patch.

4.9.4(g) Gaps ≥1⁄16" between the patch and the pipe also shall be sealed with caulk.

4.9.5 Finishing Mesh Patches on Walls

4.9.5(a) Cover the plumbing patch with a light-weight spackling or drywall joint compound.

4.9.5(b) Finishing material shall completely cover the patch and overlap onto wall.

4.9.5(c) The patch shall be finished to blend with the surrounding wall surface.

4.9.6 Finishing Mesh Patches on Floors (Fig. 32-18)

4.9.6(a) Install mesh floor patches only inside a cabinet (not in exposed locations) directly onto the cabinet bottom floor/sheathing.

4.9.6(b) Install fasteners (e.g., sheet metal screws, nails, or staples) as needed to ensure permanent attachment.

4.9.6(c) Cover patches shall be covered with lightweight, non-shrinking, exterior-grade spackling compound, drywall joint compound, or equivalent.

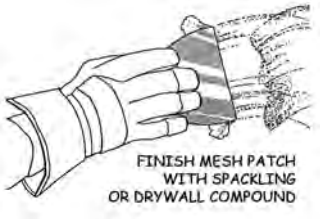


Fig. 32-18: Mesh Patches on Floors

4.9.7 Knee Walls

4.9.7(a) Seal cracks and gaps between the knee wall and the living space (at the attic floor, the walls, and the ceiling).

4.9.8 Sill Plate

4.9.8(a) Seal cracks and gaps at the bottom of each wall.

4.9.8(b) When molding is in place, caulk gaps ≥1⁄16".

4.9.8(c) Seal from the interior of the home and from the garage for the wall separating the garage from the living space.

4.9.8(d) Check carefully for bypasses in junctions between the main house and additions and in step-down rooms (especially a garage, converted porch, etc.).

4.9.9 Top Plate

4.9.9(a) Seal cracks and gaps at the top of each wall.

4.9.9(b) When molding is in place, caulk gaps ≥1⁄16".

4.9.10 Electrical Boxes

4.9.10(a) Seal visible gaps around electrical boxes and light fixtures in the ceiling, wall, or floor. (Do not remove fixtures to find gaps behind the housing.)

4.9.10(b) When installing cover plate gaskets, caulk or spackle large gaps around a box that the gasket cannot seal completely.

4.10. Wall Bypasses

4.10.1 A wall bypass is a penetration from the living space into the wall cavity that allows communication of conditioned air between the home and the building envelope.

4.10.2 Interior Wall Openings

4.10.2(a) Cavities shall be sealed with filler board and sealant.

4.10.2(a1) Foam board, duct board, radiant barrier, or other approved rigid barrier materials are acceptable to use for filler board (Fig. 32-19).

4.10.2(b) Silicone or acoustical caulk or foam sealant shall be used to seal the filler board.

4.10.2(c) The filler board shall be secured as needed with mechanical fasteners (screws, staples, or nails) to ensure a complete and permanent seal.

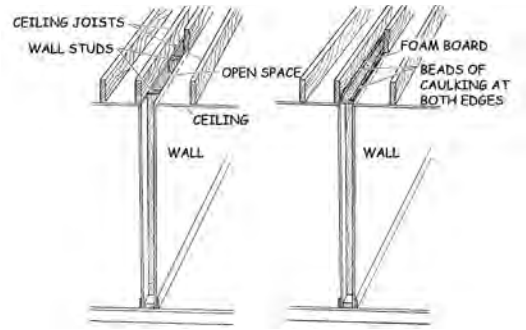


Fig. 32-19: Interior Wall Openings

4.10.3 Exterior Wall Openings

4.10.3(a) Cavities shall be sealed with filler board and sealant.

4.10.3(a1) Foam board, duct board, radiant barrier, or other approved barrier material may be used for filler board.

4.10.3(b) Silicone or acoustical caulk or foam sealant shall be used to seal the filler board.

4.10.3(c) The filler board shall be secured, as needed, with mechanical fasteners (screws, staples, or nails) to ensure a complete and permanent seal.

4.10.4 Cover Plate Gaskets

4.10.4(a) Location

4.10.4(a1) Gaskets shall be installed under cover plates located on the inside of walls between conditioned and unconditioned spaces limited to the following:

- Electrical switches and receptacles
- Telephone jacks and television cable lines
- Between apartments in multi-family units

4.10.4(b) Installation

4.10.4(b1) All locations

- The gasket shall match the switch/ receptacle style (Fig. 32-20).
- Standard switches and receptacles shall have factory-made gaskets.
- Rocker-style switches and rectangular receptacles (e.g., ground fault circuit interrupter) shall have gaskets intended for that application.
- The gasket shall cover the gap between the utility box and the surrounding wall material.

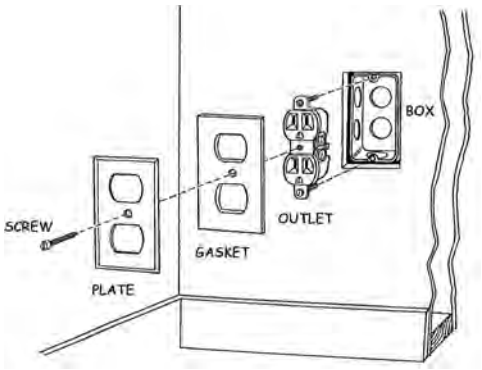


FIG. 32-20: COVER PLATE GASKET INSTALLATION ON AN OUTLET

- When the utility box is an odd size and standard gaskets will not work, the gap between the box and the wall shall be filled with caulk or spackle.
- The plate shall cover the gasket completely.

4.10.4(b2) Damaged cover plate

- Cracked or missing cover plates must be replaced to accommodate gaskets per Section 1 General Installation Guidelines, Limited Home Repair.

4.11. Weatherstripping

4.11.1 General Requirements

4.11.1(a) Weatherstripping shall:

4.11.1(a1) Effectively reduce air leakage without hampering the door, window, or access cover operation

4.11.1(a2) Be installed and adjusted to provide a continuous barrier to infiltration along its entire length

4.11.1(a3) Be installed in full-length pieces and in accordance with the manufacturer's instructions

4.11.1(b) When metal stock is cut or trimmed:

4.11.1(b1) Burs shall be removed

4.11.1(b2) Sharp edges and ends shall be rounded and smoothed

4.11.2 Exterior Doors

4.11.2(a) Standard weatherstripping consists of door jamb and door bottom weatherstripping.

4.11.2(b) Faulty weatherstripping shall be removed before new retrofit weatherstripping is installed.

4.11.2(b1) Exception: See Doors with factory-installed weatherstripping.

4.11.2(c) Allowable weatherstripping applications are shown in Table 32-2.

Table 32-2: Exterior Door Weatherstripping Application by Location

Location	Acceptable Types	
Wooden Door Jambs	• Rigid gasket • Spring or cushion metal	• Replacement kerf-in bulb and foam
Metal Door Jambs	• Rigid gasket • Cushion synthetic	• Flanged bulb • Closed-cell foam (in compression only)
Astragals on Double Doors	• Rigid gasket • Spring or cushion metal • Cushion synthetic • Flanged bulb	• Replacement kerf-in bulb and foam • Closed-cell foam and compression bulb (in compression only)
Threshold Elevators/Shims	• Non-wood: Aluminum and vinyl/plastic • Solid wood: Redwood, cedar, pressure-treated fir, or solid hardwood (i.e., must be degradation-resistant and exterior-grade).	

4.11.2 (d) Fire-rated doors and jambs

4.11.2 (d1) Doors and jambs labeled to have a fire rating of >20 minutes shall not be weatherstripped, have screws installed in the door or jamb, or be modified at the door bottom unless:

- Installation is allowed by the local building department or fire marshal
- The weatherstripping and installation meet the specifications and listing requirements of the door and jamb manufacturer(s)
- Documentation of compliance is kept in the client file

4.11.2 (e) Doors with factory-installed weatherstripping

4.11.2 (e1) Removal of the existing weatherstripping (interlock, kerf-in bulb, and magnetic types) is not required when the existing material does not interfere with proper operation of the door and the new weatherstripping.

4.11.2 (f) Door jamb weatherstripping

4.11.2 (f1) See Table 32-2 for allowable types.

4.11.2 (f2) Retrofit weatherstripping shall be installed on all three sides of the jamb (Fig. 32-21).

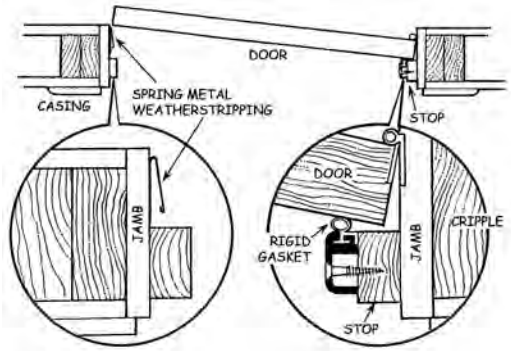


Fig. 32-21: Door Jamb Weatherstripping

4.11.2 (f3) Trim the weatherstripping corners and joints to provide a continuous barrier to infiltration without unnecessary gaps between the adjoining legs.

4.11.2 (f4) Rigid gasket

- Screws shall be positioned to allow for adjustment of the carrier.
- Each leg shall be one continuous strip.

4.11.2 (f5) Gasket contact

- Gasket-to-gasket contact is required at the corners (Fig. 32-22).

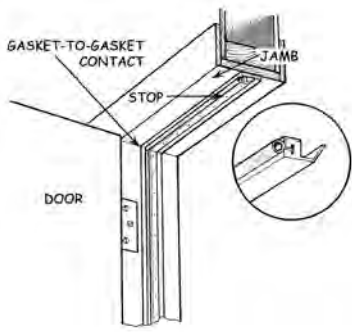


Fig. 32-22: Weatherstripping Door Jamb with Rigid Gasket

- Gasket-to-threshold contact is required at the door bottom.
  - Contact shall not be achieved by the addition of caulk.

4.11.2 (f6) Spring and cushion metal

- Sealing surfaces shall be mitered at the corners.
- Ends shall be overlapped when possible to provide a seal when compressed.
- Mechanical attachments (e.g., ¼" x ⅜" staples) shall be placed within 1" of each end and at intervals not exceeding 4".

4.11.2 (f7) Cushion synthetic, flanged bulb, and foam tape

- The mounting surface shall be thoroughly cleaned.
- The existing adhesive residue shall be removed with solvent.
- Material shall be joined and mitered at jamb corners as needed to seal the joint.

4.11.2 (f8) Corner pads

- Adhesive backing shall be supplemented with staples, tacks, etc. that penetrate the wood a minimum of ⅜".

4.11.3 Door Bottom and Threshold Weatherstripping

4.11.3 (a) Refer to Thresholds.

4.11.3 (b) See Fig. 32-8.

4.11.4 Attic and Crawlspace Access Covers Located in Conditioned Space

4.11.4 (a) Access cover frames will be weatherstripped.

4.11.4 (a1) Gaps between the frame and the ceiling/floor shall be caulked.

4.11.4 (b) A damaged/missing cover shall be replaced as a minor envelope repair (MER) before weatherstripping is installed.

4.11.4 (c) When ceiling or floor insulation will be installed, the access cover will be insulated in accordance with the insulation standard.

4.11.4 (d) Allowable weatherstripping applications are shown in Table 32-3.

TABLE 32-3: ATTIC/CRAWLSPACE ACCESS COVER WEATHERSTRIPPING APPLICATIONS

Access Cover type	Acceptable types
Horizontal Access Doors/ Covers	• Open-cell foam is standard; however, in visible locations, closed-cell foam, cushion synthetic, and flanged bulbs are acceptable if the thickness is ≤3⁄16" after the access door/cover is closed.
Vertical Access Doors (e.g., Knee Wall Doors)	• Materials approved for entrance doors shall be used.
Pull-Down Attic Stairs	• Materials approved for attic access covers shall be used.

4.11.4 (e) Install weatherstripping on attic (Fig. 32-23) and crawlspace entry doors/covers accessed from a conditioned space.

4.11.4 (e1) Access cover weatherstripping shall be installed on the surface that provides the best adhesion (i.e., smooth wood trim rather than a textured drywall lid).

4.11.4 (e2) The mounting surface shall be free of dust and debris.

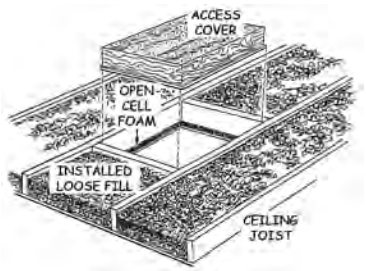


FIG. 32-23: WEATHERSTRIPPING HORIZONTAL ATTIC ACCESS COVER

4.11.4 (f) Attic stairs with bottom door or stairs with top lids

4.11.4 (f1) Weatherstrip the bottom door (or top lid if there is no bottom door).

4.11.4(g) Pull-down stairs

4.11.4(g1) The entire pull-down stair assembly will be covered with an airtight and removable/openable enclosure inside the attic space.

4.11.5 Appliance Enclosure Door Weatherstripping

4.11.5(a) Weatherstripping shall be installed to prevent the entry of combustion byproducts into the living space in accordance with Appendix A Combustion Appliance Safety Protocol and only when the CVA is all taken from the outdoors and is adequate.

4.11.5(b) Allowable applications are shown in Table 32-4.

4.11.5(c) Weatherstripping shall be installed in accordance with the instructions for exterior doors.

TABLE 32-4: APPLIANCE ENCLOSURE WEATHERSTRIPPING APPLICATIONS

Enclosure Component	Acceptable Types
Enclosure Door Jamb	• Rigid gasket • Spring and cushion metal • Cushion synthetic • Flanged bulb • Open- or closed-cell foam tape (open-cell foam shall not be exposed to sunlight).
Enclosure Door Bottom and Threshold	• Materials approved for exterior door bottoms and thresholds shall be used. See Door Repair.

4.11.6 Window Weatherstripping

4.11.6(a) Continuous and complete weatherstripping will be installed on the bottom of the lower sash where it makes contact with the sill and at the top off the upper sash (when applicable) where it makes contact with the upper part of the frame.

4.11.6(b) Windows that do not open (e.g., fixed type, windows that are painted or blocked shut, etc.) do not require weatherstripping.

4.11.6(b1) When the top sash of a double-hung window is held in a partially-open position by paint and if repair is feasible, it must be freed (by cutting paint), closed as tightly as possible, latched, and caulked as needed to stop air leaks.

4.11.6(c) With the installation of weatherstripping, all windows shall continue to be operable.

4.11.6(c1) The operation of egress windows shall not be impeded by weatherstripping or caulking.

4.11.6(d) Allowable applications are shown in Table 32-5.

Table 32-5: Window Weatherstripping Material by Window Type

Window Type	Acceptable Types	
Metal Casements	• Cushion synthetic • Closed-cell foam	• Rigid gasket
Wooden Casements	• Cushion synthetic • Spring or cushion metal	• Closed-cell foam • Rigid gasket
Wooden Double-Hung	• Rigid gasket • Spring or cushion metal • Flanged bulb	• Closed-cell foam • Vinyl or metal jamb liner
Metal and Plastic Vertical Sliders	• Cushion synthetic • Flanged bulb	• Closed-cell foam • Vinyl jamb liner
Horizontal Sliding Aluminum Windows and Glass Doors	• Replacement pile • Cushion synthetic	• Flanged bulb • Closed-cell foam
Awning and Jalousie Windows	• Commercially available specialty materials may be installed on a window with a functional operating mechanism. • Weatherstripping shall effectively reduce air leakage without hampering window operation.	

4.11.6(e) Window preparation

4.11.6(e1) Window repairs (e.g., including but not limited to replacement of missing glazing compound on the sash, installation of exterior caulking and exterior storm windows, etc.) will be conducted prior to the installation of weatherstripping.

4.11.6(e2) Repairs to reduce air infiltration (e.g., new latch for meeting rail connection, pulley seals, rope caulking for other cracks, interior storm windows, etc.) will be done prior to the installation of weatherstripping.

4.11.6(e3) Sash locks on wooden double-hung windows

- When needed to prevent catastrophic leakage, install new sash locks or adjust existing sash locks so that the meeting rails of the upper and lower sashes are flush and in full contact.
- After installation or adjustment of the sash locks, no gaps shall be visible between the two sashes.

4.11.6(e4) Install and/or adjust stops on wood windows to eliminate visible gaps between the stops and the jamb.

- Wood stops will be sealed to glass with an appropriate sealant.

4.11.6(e5) Wood windowsills

- Before installing weatherstripping, prime and water-seal the windowsill if it is bare wood. Scrape and sand the sill smooth before sealing if the paint is degraded so much that the weatherstripping will not properly seal against it.

4.11.6(f) Window weatherstripping installation

4.11.6(f1) The existing weatherstripping and sash sealant shall be removed.

4.11.6(f2) Surfaces where the sill meets the sash shall be cleaned.

4.11.6(f3) Weatherstripping shall be installed and adjusted to provide a continuous barrier to infiltration along all edges of the window opening (Fig. 32-24).

4.11.6(f4) Weatherstripping will be installed on the bottom of the lower sash where it makes contact with the sill and at the top of the upper sash where it makes contact with the upper jamb.

4.11.6(f5) The seal between the fixed components of the window (e.g., jambs, sill) shall be continuous and complete while maintaining the operability of the window.

4.11.6 (f6) Replacement pile

- Fit the pile snugly into the retaining channel (Fig. 32-25).

4.11.6 (g) Weatherstripping sliding glass doors (SGDs)

4.11.6 (g1) Pile

- Worn pile shall be replaced with new pile in the retaining channels when feasible (Fig. 32-26).

4.11.6 (g2) Self-adhesive compression material

- The existing material shall be removed, and the surface cleaned.
- Cushion synthetic, flanged bulb, or closed-cell foam tape shall be installed in the compression location only (e.g., on the latch side of the jamb).
- Following installation, the door must close and latch properly.

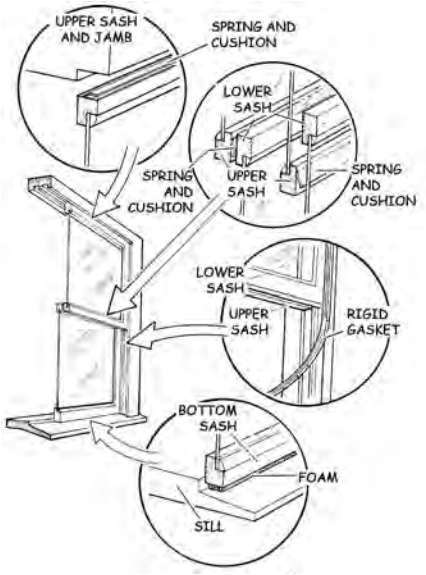


Fig. 32-24: Window Weatherstripping Placement

4.12. Window and SGD Repair

4.12.1 Window and SGD Replacement

4.12.1 (a) Window and SGD replacement as an IRM must be justified by catastrophic leakage. See Section 33 Windows and Sliding Glass Doors for more information.

4.12.2 Window Repair

4.12.2 (a) Window repair includes:

4.12.2 (a1) Repair, sealing, or component installation to reduce infiltration (e.g., new latch for meeting rail connection, pulley seals, rope caulking for other cracks)

4.12.2 (a2) Repair of the window sash or frame and installation of glazing compound, gaskets, and other items required to seal the glass and sash

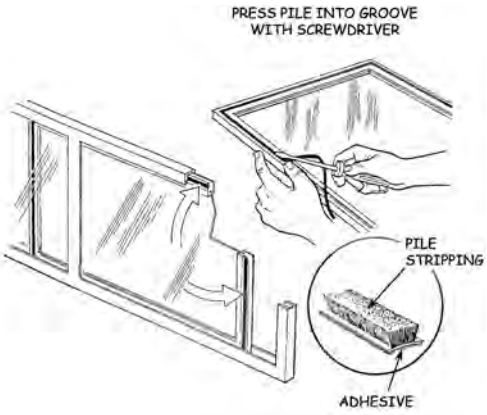


Fig. 32-25: Replacing Window Pile Weatherstripping

4.12.3 SGD Repair

4.12.3 (a) SGD repair includes replacement of:

4.12.3 (a1) The interlock between the panes of a dual-pane glass door

4.12.3 (a2) Malfunctioning roller assemblies

4.12.4 Glass Replacement

4.12.4 (a) The following conditions apply regarding glass replacement:

4.12.4 (a1) When only one pane in a dual-pane window is broken, the broken pane will be removed only if it presents a safety issue.

- If both panes in a dual-pane window are broken, the window will be assessed for catastrophic leakage and replacement.

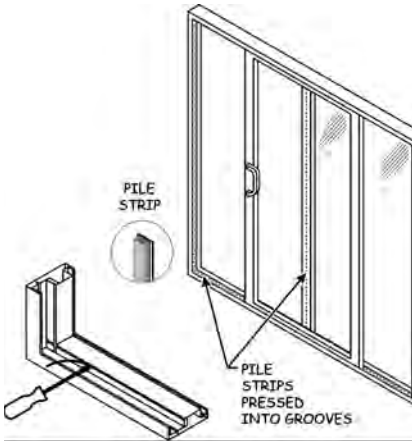


Fig. 32-26: Sliding Glass Door Pile Weatherstripping

4.12.4 (a2) Cracks <6" from window edge to window edge will be ignored.

4.12.4 (a3) Operable windows (movable sashes) shall not be converted to fixed panes.

4.12.4(a4) A storm windows shall not be installed as a substitute for replacing broken glass.

4.12.4(a5) When four or fewer BB holes are present, fill them with clear caulk.

4.12.4(b) Documentation of window repair condition(s) is required for each window to be repaired. To prove catastrophic leakage, measurements and calculations of the gap size must be provided on the CSD 540 Dwelling Assessment Form.

4.12.4(c) Pre-treatment of sash

4.12.4(c1) Glass channels will be clean and free of debris.

4.12.4(c2) Treat wood sashes with mineral oil before glazing compound is installed.

4.12.4(c3) Remove rust from steel sashes and apply rust-inhibiting metal primer.

4.12.4(d) Glass selection

4.12.4(d1) Replacement glass will be sized ⅛"–3⁄16" smaller than the opening to allow for movement of the frame.

4.12.4(d2) Glass will be selected with comparable tint and coating (color and look).

4.12.4(d3) Safety glass

- See Section 1 General Installation Guidelines, Safety Glass in Windows and Doors.
- Polycarbonate may be used instead of tempered glass when allowed by the client.

4.12.4(d4) Bathroom windows

- Replace obscure glass on the ground floor with obscure glass when the bottom edge of the window is <60" above the finished floor.

4.12.4(e) Glazing compound

4.12.4(e1) Glazing compound must be used only in sashes designed for its use.

4.12.4(e2) Caulk must not be used as a substitute for glazing compound.

4.12.4(f) Glazing channel

4.12.4(f1) Metal and vinyl windows:

- A watertight seal must be present around the sash.
- Secure/seal the glazing with a glazing spline, glazing channel gasket, or snap-in glazing bead.
  - The replacement gasket/spline must be properly sized.
  - The existing gasket/spline may be reused when it is in satisfactory condition to provide a complete seal.
- Clear silicone caulk or equivalent may be added to fill any gaps.
- Where a proper gasket/spline cannot be provided, stabilize the glass with clear silicone caulk or equivalent.

4.12.4(g) Wood sash

4.12.4(g1) Install push points:

- A maximum of 8" apart
- Within 4" of each corner
- On each edge to secure the glass in the frame

4.12.4(g2) Cushion and finish beads (Fig. 32-27)

- The cushion bead must be continuous and free of voids.
- The finish bead will:
  - Be free of gaps
  - Be tooled in place and uniform with existing beads
  - Not be visible from the interior side

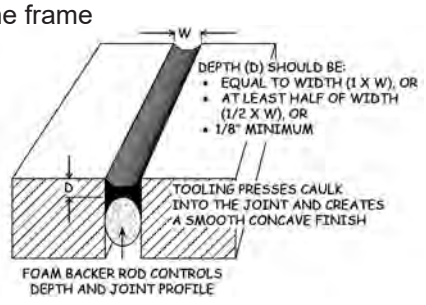


FIG. 32-27: A HIGH-QUALITY FINISHED BEAD

4.12.4(h) Metal sash

4.12.4(h1) Reinstall spring clips (Fig. 32-28):

- A maximum of 12" apart and
- Within 4" of each corner

4.12.4(h2) Reinstall continuous angles, stops, or glazing spline to keep the glass securely in place.

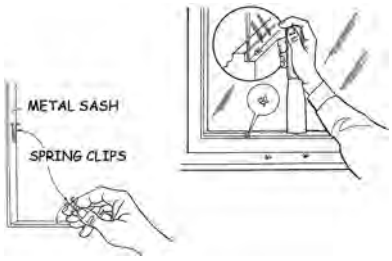


FIG. 32-28: SPRING CLIP INSTALLATION

5. MOBILE HOME–SPECIFIC

5.1 Mobile home installations are the same as those for conventional homes except as specified below.

5.2. Access Hatches

5.2.1 Access cover requirements for conventional homes do not apply to mobile homes.

5.3. Mobile Home Doors

5.3.1 All Mobile Home Doors

5.3.1(a) Ensure the opening is structurally sound, square, plumb, and level in accordance with the manufacturer's recommendations (Fig. 32-29).

5.3.1(b) When diagonal measurements of the door opening differ by more than ⅛":

5.3.1(b1) The chassis should be checked and leveled when possible or

5.3.1(b2) The rough opening must be adjusted/ shimmed to provide satisfactory mounting surfaces for the replacement frame

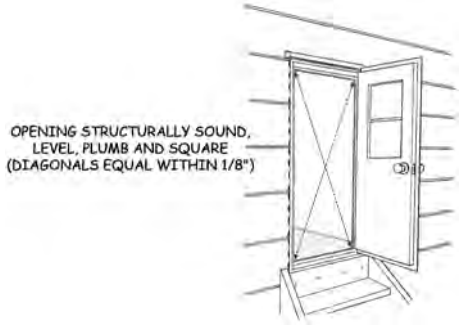


FIG. 32-29: MOBILE HOME DOOR REQUIREMENTS

5.3.1(c) Seal water penetration points.

5.3.1(d) Sound anchorage is necessary for the replacement unit.

5.3.1(e) The floor must be structurally solid to properly support the replacement sill.

5.3.1(f) Remove the existing door frame, anchors, and sealant and ensure all mounting surfaces are clean and smooth (Fig. 32-30).

5.3.1(g) Install insulation in gaps between the door frame and rough opening (e.g., mineral fiber or backer rod.

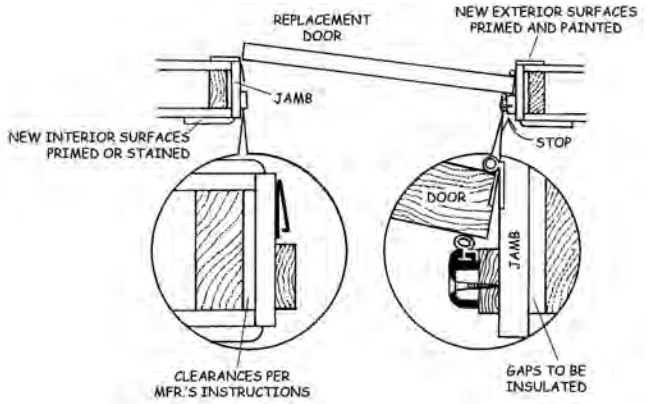


FIG. 32-30: MOUNTING SURFACES PREPARED AND GAPS CAULKED/INSULATED

5.3.1(g1) Injected foam is not allowed.

5.3.1(h) Caulk exterior and interior gaps in accordance with Caulking.

5.3.2 All Swinging Doors

5.3.2(a) Install the sill and ensure it is level.

5.3.2(b) The hinge side must be securely supported and plumb.

5.3.3 In-Swinging "House-Type" Doors

5.3.3(a) Installation requirements for door blanks and pre-hung units with wooden frames are the same as for conventional home hinged doors.

5.3.3(b) For a pre-hung door with a flanged metal frame, see the applicable procedures in Flush-Mount Doors with External Flange/Fin for positioning, sealing, and attaching out-swinging flanged units (Fig. 32-31).

5.3.4 Out-Swinging Doors

5.3.4(a) Position the replacement mounting flange to cover the holes left by the removal of the pre-existing door (Fig. 32-32).

5.3.4(b) Apply elastomeric caulk or non-hardening sealant/putty tape to the back of the mounting flange.

5.3.4(c) The sill must rest on the floor or have solid support from jamb to jamb.

5.3.4(d) Center the unit side-to-side in the opening with the sides plumb and the frame square.

5.3.4(e) Anchor the flange securely with screws spaced in accordance with the manufacturer's instructions.

5.3.4(f) Install hardware per the manufacturer's instructions (e.g., lockset, door chain, pneumatic closer, etc.).

5.3.5 Flush-Mount Doors with External Flange/Fin

5.3.5(a) Door bottom

5.3.5(a1) A door shoe or shoe-and-threshold combination shall be utilized.

5.3.5(a2) If not feasible, a bumper threshold is allowed.

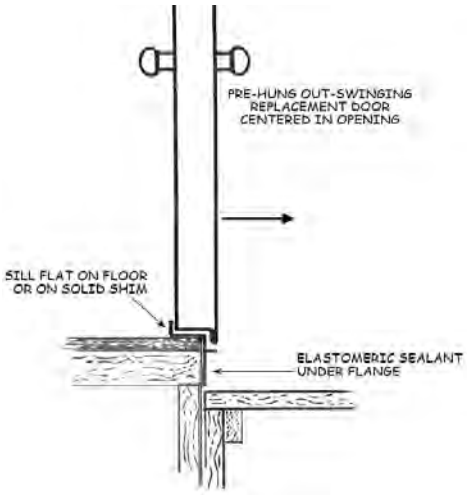


Fig. 32-31: Pre-Hung Outswinging Mobile Home Door

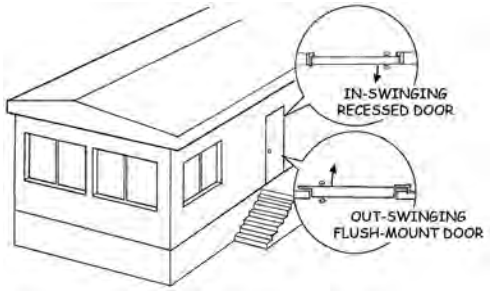


Fig. 32-32: In-Swinging and Out-Swinging Doors for Mobile Homes

5.4. Mobile Home Glass Replacement

5.4.1 General Requirements

5.4.1(a) Select glass with comparable tint and coating (standard color and look).

5.4.1(b) Seal the glass in accordance with the original installation design.

5.4.1(c) Replace or install stops as needed to prevent catastrophic leakage.

5.4.2 Glass Replacement in Awning Windows

5.4.2(a) Replace broken glass and repair or replace damaged gaskets.

5.4.2(b) Glass thickness must allow for proper installation into the channel with the gasket installed.

5.4.2(c) Adjust the reassembled sash as needed to operate smoothly and close properly.

5.4.2(d) The applicable procedures for awning windows will be used for glass replacement in sliding windows.

5.4.3 Flanged Window Frame Removal

5.4.3(a) When a flanged window frame is removed to facilitate glass replacement:

5.4.3(a1) Maintain the integrity of the sealant on the back side of the flange

5.4.3(a2) Use elastomeric caulk or non-hardening sealant/putty tape as needed for a complete seal

5.4.3(a3) Ensure the sealant application surface is clean

5.4.3(a4) Replace stripped or damaged screws

5.5. Mobile Home Window Repair

5.5.1 Items that reduce infiltration may be repaired, replaced, sealed, or installed to prevent catastrophic leakage.

5.5.2 Items that reduce water infiltration (e.g., replacement glazing on sash, exterior caulking, exterior storm windows, storm doors, drip cap, J-channel, flashing) will be repaired, replaced, or installed.

5.6. Mobile Home Weatherstripping

5.6.1 Installation must conform with the manufacturer's instructions, Department of Housing and Community Development (HCD) requirements, and installation guidelines for conventional homes.

5.6.2 Installation requirements for mobile homes are the same as those for conventional homes except as specified below and identified in Table 32-1.

5.6.3 Flush-Mount Doors with Exterior Flange

5.6.3(a) When mechanically attached materials are not feasible, the most effective and durable of the following alternatives will be used:

5.6.3(a1) Cushion synthetic

5.6.3(a2) Flanged bulb

5.6.3(a3) Closed-cell foam tape

5.6.3(a4) Round tube

5.6.3(a5) Vinyl V-strip

5.6.3(b) A bumper threshold may be used to seal the door bottom when that is the best option.

5.7. Mobile Home Sealing Activities

5.7.1 The assessment of the unit will determine the structural integrity, size of wall studs, insect infestations, accessibility, and the number, type, size, and location of penetrations.

5.7.2 See "Prescriptive Shell Sealing Priority List" on the CSD 704 Shell Leakage Data Sheet for mobile home caulking priority.

5.7.3 Top/bottom bypasses on ventilated metal exterior walls will not be sealed.

5.7.4 Work will not be attempted on any mobile home roof that is substandard or unsafe.

5.7.5 Caulking Locations in Mobile Homes

5.7.5(a) Interior envelope leaks ≥1⁄16" wide:

5.7.5(a1) Gaps <3⁄8" will be caulked without filler material.

5.7.5(a2) Gaps 3⁄8"–5⁄8" will be caulked only if filler material (e.g., foam backer rod) can be properly installed/secured and covered with at least a 1⁄8"-deep bead of caulk.

5.7.5(b) Interior seams and joints

5.7.5(b1) Gaps 1⁄16"–5⁄8" will be caulked, including:

- Trim around windows and doors, in room corners, and along ceiling perimeters
- Accessible baseboards (i.e., not covered with carpeting or obstructed by heavy furniture)

5.7.5(b2) Trim down the center (marriage line) of a double-wide unit on both edges whenever possible.

5.7.5(c) Appliance enclosure walls and exhaust duct penetrations will be repaired/patched or sealed per Non-visible interior locations.

5.7.5(d) Exterior envelope holes and penetrations

5.7.5(d1) All exterior leaks and penetrations will be sealed to the extent possible.

5.7.5(d2) Exterior wall air sealing:

- Intentionally ventilated walls will not be sealed at vent locations (e.g., weep holes).
- Backing or infill will be provided as needed to meet the specific characteristics of the selected sealant and the characteristics of the penetration.

5.7.6 Marriage Line

5.7.6(a) All accessible holes and penetrations at marriage lines will be sealed continuously at end walls, floors, and ceiling.

5.7.6(b) Backing or infill will be provided at the marriage line as needed.

5.7.6(c) All remaining gaps will be sealed with an approved material.

5.7.6(d) External caulking at marriage lines will be elastomeric caulk or minimally expanding foam.

5.7.6(d1) It is acceptable to leave foam exposed in the undercarriage area.

5.7.7 Ceilings

5.7.7(a) Ceiling repair material must meet or exceed the strength of the existing ceiling material.

5.7.7(b) The ceiling repair must span from truss to truss, or blocking must be added as needed for support.

5.7.7(c) All accessible damaged penetrations through the ceiling air barrier must be repaired.

5.7.7(d) All accessible damaged vapor barriers will be repaired.

5.7.8 Floors

5.7.8(a) Floor repair material will meet or exceed the strength of the existing floor material.

5.7.8(b) The repair will span from joist to joist with blocking added as needed to support the floor.

5.7.8(c) Patches <1 sq. ft. do not require repairs from joist to joist.

5.7.8(d) Floor repair material will be glued, fastened, and air sealed.

5.7.9 Bellyboard/Bottomboard

5.7.9(a) Patching material must meet the specific characteristics of the bottom board material and the characteristics (hole size and type) of the penetrations (e.g., electrical, polyvinyl chloride, gas line, dryer vent).

5.7.9(b) The patch will not bend, sag, or move once installed.

5.7.9(c) The patch will be permanent and have a minimum service life of 20 years.

5.7.9(d) Combustion air supplies will be labeled for identification and will not be blocked or sealed.

5.7.10 HPDs in Mobile Homes

5.7.10(a) High-temperature sealant will be used.

5.7.10(b) Flue pipe ceiling penetrations (Table 32-2)

5.7.10(b1) Gaps ≤¼" wide will be sealed with high-temperature caulk or repaired/patched.

5.7.10(b2) Gaps >¼" will be repaired/patched as prescribed in Shell Sealing.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply except as specified below.

6.1.2(a) Fire-rated doors and jambs

6.1.2(a1) Check the labeling on the dwelling unit door to the hallway/common area to confirm the fire rating.

- Doors and jambs labeled to have a fire rating of >20 minutes shall not be weatherstripped, have screws installed in the door or jamb, or be modified at the door bottom unless:
  - Installation is allowed by the local building department or fire marshal
  - The weatherstripping and installation meet the specifications and listing requirements of the door and jamb manufacturer(s)
  - Documentation of compliance is kept in the client file

6.1.3 Common area installation (e.g., in a lobby, utility room, laundry room, etc. within the same thermal boundary as dwelling units) is allowed when justified by an energy audit for a whole-building project, per Appendix D Energy Audit/Priority List Protocol.

6.1.3(a) Common area installation is not allowed when only an individual unit in a multi-family building will be served.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 Shell leakage testing, infiltration reduction (shell sealing), and inspector retesting, are required on 100% of units for which DOE funds are used.

7.1.1(a) Exception: Shell leakage testing is not required for multi-family dwellings of four stories or more.

7.1.2 Shell testing and shell sealing shall be blower door–driven and conducted in accordance with Appendix C Shell Leakage Testing Protocol.

7.1.3 To assess for the Infiltration Reduction measure as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.3(a) The form will determine if the measure will be installed in the Audit path or the Priority List (PL) path.

7.1.3(b) When assessing for this measure for the Audit path, feasibility will be decided by the energy audit with a Measure savings-to-investment ratio (SIR) and Dwelling SIR.

7.1.3(b1) When the measure is feasible based on the audit, and the measure is categorized as a “Major” measure (i.e., Infiltration Reduction, Duct Sealing, Ceiling Insulation, Floor Insulation, and Wall Insulation), it shall be installed or the dwelling must be deferred.

7.1.3(c) When assessing for the measure in the PL path, the feasibility will be based on building type and characteristics.

7.1.3(c1) PL measures are classified as Mandatory or Optional based on building type.

- Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.
- Optional measures may be installed only after all feasible Mandatory PL measures have been installed.

7.1.3(c2) If an energy conservation measure is not on the PL for a specific building type, a site-specific energy audit with all feasible measures shall be conducted.

7.1.3(d) Exceptions:

7.1.3(d1) Door repair or replacement for catastrophic leakage is not allowed with DOE WAP funds, either as an individual measure or collectively within the Infiltration Reduction measure.

7.1.3(d2) Door replacement as an energy efficiency upgrade is not permitted with DOE WAP funds.

7.1.3(d3) Door repair or replacement shall be allowed only as an incidental repair when necessary to protect or preserve an ECM being installed as a Limited Home Repair (LHR). The LHR must be justified by a site-specific energy audit according to the procedures described in the Appendix D Energy Audit/Priority List Protocol.

7.1.4 If a client refuses a feasible Audit path Major measure, Mandatory Priority List path, or Health & Safety measure, the entire dwelling shall be deferred.

7.1.5 When this measure is fully leveraged or co-funded with LIHEAP, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/ Priority List Protocol.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2(a) Excerpted from 2017 SWS 3.1002.1:

7.2.2(a1) Support material will be installed for spans wider than 24" except when rigid air barrier material is rated to span a greater distance under load (e.g., wind, insulation)

7.2.2(b) Excerpted from 2017 SWS 3.1003.2:

7.2.2(b1) Sealants shall be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference.

7.2.2(c) Excerpted from 2017 SWS 3.1003.4:

7.2.2(c1) Pre-fabricated units [to seal a dropped ceiling at the attic floor] may be used when meeting the desired outcome

7.2.2(d) Excerpted from 2017 SWS 3.1003.6:

7.2.2(d1) Side of stud bays will be sealed with rigid material from bottom of soffit to top-plate

7.2.2(e) Excerpted from 2017 SWS 3.1201.3:

7.2.2(e1) Details [repairs] that reduce water infiltration will be repaired, replaced, sealed, or installed (e.g., adjust threshold, caulk jamb to threshold, caulk trim, flashing)

7.2.2(f) Excerpted from 2017 SWS 3.1802.1:

7.2.2(f1) Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, “GREENGUARD Children and Schools,” or comparable certifications

7.2.3 Mobile Home

7.2.3(a) Requirements for mobile homes are the same as those for single-family homes.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Ensure the CSD 704 Shell Leakage Data Sheet is properly filled out and IRM sealing measures were properly performed.

8.1.2 Perform CAS testing in accordance with Appendix A Combustion Appliance Safety Protocol to ensure that no open combustion appliances located in the living space are creating a hazardous atmosphere as a result of the IRM activities.

8.1.3 Retesting for shell leakage is required on a minimum of 20% of inspected units as part of the quality assurance post-inspection for LIHEAP units per Appendix C Shell Leakage Testing Protocol.

8.2. Client Education

8.2.1 Proper operation and maintenance of fireplace doors and/or dampers shall be explained to the client.

8.2.2 Occupants will be notified of changes or repairs made to doors and/or windows and will be educated on how to operate and maintain weatherstripping and caulk around door/window and trim.

8.2.2(a) Occupants will be advised of possible drying and shrinking effects of applicable materials, proper ventilation to prevent moisture issues, and other potential warranty issues.

8.2.3 Occupants will be educated about the need to keep the door from the garage to the house closed.

8.2.4 Occupants will be advised to not warm up vehicles or use any gas engine appliances or grills in the garage, even if the main door is left open.

8.3. Clean-Up and Disposal Requirements

8.3.1 Installation debris shall be removed from the property and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 Access Covers

9.1.1(a) LIHEAP: 4 years

9.1.1(b) DOE: 10 years

9.1.2 Caulking

9.1.2(a) LIHEAP: 4 years

9.1.2(b) DOE: 10 years

9.1.3 Cover Plate Gaskets

9.1.3(a) LIHEAP: 20 years

9.1.3(b) DOE: 10 years

9.1.4 Door Replacement

9.1.4(a) LIHEAP: 15 years

9.1.4(b) DOE: 20 years

9.1.5 Door Repair (Including SGDs)

9.1.5(a) LIHEAP: 15 years

9.1.5(b) DOE: 10 years

9.1.6 Glass Replacement

9.1.6(a) LIHEAP: 10 years

9.1.6(b) DOE: 10 years

9.1.7 MER

9.1.7(a) LIHEAP: 4 years

9.1.7(b) DOE: 10 years

9.1.8 SGD Replacement

9.1.8(a) LIHEAP: 15 years

9.1.8(b) DOE: 10 years

9.1.9 Storm Windows

9.1.9(a) LIHEAP: 10 years

9.1.9(b) DOE: 15 years

9.1.10 Vent Covers

9.1.10(a) LIHEAP: 4 years

9.1.10(b) DOE: Not applicable to this measure.

9.1.11 Weatherstripping

9.1.11(a) LIHEAP: 4 years

9.1.11(b) DOE: 10 years

9.1.12 Window Repair

9.1.12(a) LIHEAP: 20 years

9.1.12(b) DOE: 10 years

9.1.13 Window Replacement

9.1.13(a) LIHEAP: 20 years

9.1.13(b) DOE: 20 years

9.1.14 Whole House Air Sealing

9.1.14(a) LIHEAP: Not applicable to this measure.

9.1.14(b) DOE: 10 years

9.2 Restricted Materials

9.2.1 All MER sealing materials shall be used in accordance with safety data sheet instructions, material specifications, and manufacturers' instructions. The following special restrictions also apply:

9.2.2 UL 181 metallic tape shall not be used for any shell sealing purpose in any location (exposed or non-visible).

9.2.3 Foam board may be left exposed only in the attic and crawlspace.

9.2.3(a) Foam board installed in other locations shall be covered in accordance with local codes.

9.2.4 Foam sealant may be used to seal gaps in penetrations (e.g., plumbing and electrical), subject to the following limitations:

9.2.4(a) Gap size and use shall conform with the manufacturer's specifications and local code.

9.2.4(b) Fire-resistant foam (e.g., orange or red) shall be used to seal penetrations in common walls/floors/ceilings between adjacent residences (e.g., multi-unit dwellings).

9.3 Attic Access Cover—Horizontal

9.3.1 Cover Material

9.3.1(a) Field-fabricated access door: Gypsum (drywall), minimum ⅝" thick

9.3.1(b) Prefabricated access door assembly: Commercially available

9.3.2 Framing Material (Joist Blocking)

9.3.2(a) Same dimension as joist (e.g., 2" x 4" or 2" x 6")

9.3.2(b) No. 2 hem-fir or better

9.3.3 Trim Material

9.3.3(a) Window/door trim/molding (interior- or exterior-grade)

9.3.3(b) Adequate thickness and width to attach to ceiling joists and extend into the opening far enough to support the cover (e.g., ⅝" x 3½")

9.3.3(c) Spackle or wood putty (to cover recessed nails)

9.3.4 Attachments

9.3.4(a) Minimum 3" nails for blocking

9.3.4(b) Finish nails for attaching trim (long enough to penetrate joist at least ½", e.g., 1⅝" long)

9.3.5 Weatherstripping

9.3.5(a) Open or closed cell foam tape, in accordance with the material specification for weatherstripping

9.3.6 Insulation

9.3.6(a) Flexible or rigid insulation, with an R-value equal to the R-value of insulation on the attic floor

9.4 Attic Access Cover—Vertical

9.4.1 Cover Material

9.4.1(a) Gypsum (drywall), minimum ½" thick with plywood backing

9.4.1(b) Minimum ⅝" plywood (interior- or exterior-grade, CCX or better), for wood-only cover/door

9.4.1(c) Minimum ½" plywood (interior- or exterior-grade, CDX or better) to serve as backing for gypsum-clad cover/door

9.4.2 Framing Material

9.4.2(a) Same dimension as studs (e.g., 2" x 4")

9.4.2(b) No. 2 hem-fir or better

9.4.3 Trim Material

9.4.3(a) Window/door trim/molding (interior- or exterior-grade), minimum 2" wide

9.4.3(b) Spackle or wood putty (to cover recessed nails)

9.4.4 Hinges in Firewall Applications

9.4.4(a) Minimum 3½" x 3½" spring-loaded with adjustable tension

9.4.4(b) Adequate spring tension to make access cover self-closing

9.4.5 Attachments

9.4.5(a) Minimum 3" nails for blocking

9.4.5(b) Finish nails for attaching trim (long enough to penetrate the joist at least ½", e.g., 1⅝" long)

9.4.5(c) Corrosion-resistant screws for hinges

9.4.5(c1) Sized per hinge manufacturers specifications and

9.4.5(c2) Long enough to penetrate framing at least ½"

9.4.5(d) Heavy-duty construction adhesive (to glue plywood to gypsum)

9.4.6 Weatherstripping

9.4.6(a) Open or closed cell foam tape, in accordance with the material specification for weatherstripping or

9.4.7 Insulation

9.4.7(a) Flexible or rigid insulation with an R-value equal to knee walls

9.5 Caulking

9.5.1 Select sealants in accordance with:

9.5.1(a) Sealant compatibility with the surfaces being sealed

9.5.1(b) The size of the gap being filled

9.5.1(c) Application temperature limits

9.5.1(d) Support for expected wind and mechanical pressure loads

9.5.1(e) Allowance for expansion and contraction differential between dissimilar materials

9.5.2 Only fire-resistant materials will be used between attached dwelling units, and in contact with HPDs (e.g. chimneys, combustion appliance vents, and non-insulation contact (IC)–rated recessed lights).

9.6 Cover Plate Gaskets

9.6.1 All gaskets shall be:

9.6.1(a) Fire-resistant

9.6.1(b) Pre-cut to fit when the correct size is available

9.6.1(b1) Rocker-type switches and rectangular receptacles:

- Gaskets shall have rectangular perforations shaped for those applications (rather than using standard receptacle gaskets with rounded perforations).
  - Closed-cell foam
  - Minimum ⅛" thick

9.7 Crawlspace Access Cover—Horizontal (Indoors)

9.7.1 Cover Material

9.7.1(a) Prefabricated access door assembly (commercially available) or

9.7.1(b) Field-fabricated access door

9.7.1(c) Substrate of ¾" plywood, CCX or better

9.7.1(d) Finish lumber: No. 2 or better

9.7.2 Framing Material (Joist Blocking)

9.7.2(a) Same dimension as joist (e.g., 2" x 4" or 2" x 6")

9.7.2(b) No. 2 hem-fir or better

9.7.3 Attachments

9.7.3(a) Minimum 3" nails for blocking

9.7.3(b) Corrosion-resistant screws for hinges

9.7.3(c) Sized in accordance with hinge manufacturer's specifications and

9.7.3(d) Long enough to penetrate framing at least ⅝"

9.7.4 Weatherstripping

9.7.4(a) Open- or closed-cell foam tape, in accordance with material specification for weatherstripping

9.7.5 Insulation

9.7.5(a) Flexible or rigid insulation with R-value equal to the R-value of the floor insulation

9.8 Crawlspace Access Cover—Vertical (Outdoors)

9.8.1 Cover Material

9.8.1(a) Metal

9.8.1(a1) Screened metal vent (commercially available or shop-fabricated) or

9.8.1(a2) Solid metal access cover (commercially available or shop-fabricated)

9.8.1(a3) Metal: Minimum 20-gauge

9.8.1(a4) Screen: ¼" metal mesh or expanded metal or equivalent

9.8.1(b) Wood

9.8.1(b1) Minimum ½" exterior-grade plywood, CCX or better

9.8.2 Framing Material (box frame)

9.8.2(a) Minimum 1" x 2" redwood or pressure-treated fir, no. 2 or better

9.8.3 Hinges

9.8.3(a) Cabinet hinges or better

9.8.3(b) Corrosion-resistant

9.8.4 Latches

9.8.4(a) Cabinet latches or better

9.8.4(b) Corrosion-resistant

9.8.5 Attachments

9.8.5(a) Box frame and metal frame

9.8.5(a1) Concrete nails or corrosion-resistant screws and anchors

9.8.5(a2) Sized for ½" penetration into concrete

9.8.5(b) Corrosion-resistant screws for hinges

9.8.5(b1) Sized in accordance with hinge manufacturer's specifications and

9.8.5(b2) Long enough to penetrate framing at least ⅝"

9.9 Glazing in Doors

9.9.1 Safety glass is required except in jalousie windows and windows with panes >3" in width and height.

9.9.1(a) Polycarbonate may be used in lieu of glass if allowed by local code.

9.9.1(b) U-factor and solar heat gain coefficient (SHGC) shall comply with Table 32-6.

9.9.1(c) Safety glazing shall be permanently labeled and installed per the 2013 CRC, §R308.4.

TABLE 32-6: GLAZED DOOR PERFORMANCE REQUIREMENTS

Efficiency Factor	Climate Zone	Maximum Value
U-Factor	All	0.32
SHGC	1, 3, and 5	No requirement
	2 and 6–16	0.25

9.10 Door Repair/Replacement Materials

9.10.1 Doors—Fire-Resistance

9.10.1(a) Garage door to living space shall be:

9.10.1(a1) A 20-minute fire-rated door tested per National Fire Protection Association (NFPA) 252

9.10.1(a2) Equipped with a self-closing and self-latching device

9.10.1(b) Entrance doors in multi-family units shall have the fire rating specified by the local jurisdiction.

9.10.2 The jamb shall be:

9.10.2(a) Exterior-grade only

9.10.2(b) ⅝"-thick stock standard; ¾" minimum

9.10.3 Hardware

9.10.3(a) All door closure system components shall be base models. Ornate or complex lockset materials are not allowed.

9.10.3(b) A deadbolt is required to have a thumb turn on the interior side. (An interior key deadbolt is not allowed.)

9.10.4 Door Jamb Sealant

9.10.4(a) Injected foam is allowed only if appropriate for the intended use and installed strictly in accordance with the manufacturer's instructions.

9.10.5 Nails

9.10.5(a) Use finishing or casing nails for interior applications.

9.10.5(b) Use galvanized nails for exterior applications.

9.10.6 Shoes, Door Bottoms, and Sweeps

9.10.6(a) Solid aluminum extrusions

9.10.6(b) Pliable gasket of vinyl, thermoplastic elastomer (TPE), silicone, or equivalent

9.10.6(c) Solid aluminum carrier, 0.05" minimum nominal thickness, with elongated mounting holes 9" OC maximum

9.10.6(c1) Exception: For shoes, a plastic carrier is allowed when standard aluminum will not fit.

9.10.6(d) Shoes

9.10.6(d1) A U-shoe is standard; an L-shoe is allowed when a U-shoe will not fit.

9.10.6(d2) Shall have rain drip in exposed outdoor locations

9.10.6(d3) A tall (e.g., 3"-high) U-shoe may be used when the door bottom is cut too short or is too worn/weak to accept a standard (1½"-high) U-shoe.

9.10.6(e) Stationary sweeps shall have a pliable gasket of vinyl or silicone.

9.10.6(f) Automatic door bottom

9.10.6(f1) Retractable type only; a flip sweep is not allowed

9.10.6(g) Metal saddle threshold

9.10.6(g1) Solid aluminum only; a “gasket saddle” with a vinyl top gasket is not allowed

9.10.6(g2) Shall have a floor-sealer gasket of vinyl, TPE, silicone, or equivalent

9.10.6(h) Wooden saddle threshold

9.10.6(h1) Hardwood only; a “gasket saddle” with a vinyl top gasket is not allowed

9.10.6(i) Bumper threshold

9.10.6(i1) Solid aluminum with bumper gasket of vinyl, TPE, silicone, or equivalent

9.10.7 Threshold Risers

9.10.7(a) Risers shall be made of material that matches the threshold (aluminum or hardwood).

9.10.7(b) Screws (minimum three per riser) must be compatible with threshold materials.

9.10.8 Threshold Shim/Elevator Materials

9.10.8(a) Non-wood: Aluminum and plastic (e.g., vinyl)

9.10.8(b) Solid wood: Redwood, cedar, pressure-treated fir, or solid hardwood (degradation-resistant and exterior-grade)

9.11 Exterior Doors

9.11.8(a) Doors shall comply with the fire-resistance requirements of local code (e.g., 2016 CRC Section R337.8).

9.11.8(b) When equipped with glass, the door shall be equipped with safety glass unless the pane is <3" in height or width

9.11.8(c) Replacement doors shall be limited to standard solid core slab or panel doors. (No ornate design, stained glass, decorative windows, etc., is allowed unless required by the State Historical Preservation Office and approved by weatherization waiver.)

9.11.1 Dimensions

9.11.1(a) A 1¾" door is required when jambs are replaced.

9.11.1(b) A 1⅜" door is allowed when jabs are not replaced and a 1¾" door will not fit.

9.11.2 Composition

9.11.2(a) Non-metallic veneer: Minimum ⅛" thick with exterior-grade glue

9.11.2(b) Core:

9.11.2(b1) Wood doors must be solid core.

9.11.2(b2) Metal doors must have a minimum R-6 insulated core.

9.11.3 Finish/Sealer

9.11.3(a) All doors, including those that are cut to fit on-site, will be sealed (painted or primed) to prevent moisture intrusion.

9.11.3(b) Pre-hung doors will be factory-sealed (primed or painted).

9.11.3(c) Wood Doors

9.11.3(c1) Acceptable sealers are paint, urethane, and varnish.

- Clear “water seal” products are not allowed.

9.11.3(d) Metal doors

9.11.3(d1) Acceptable sealers are oil-based or epoxy paint only.

9.11.3(e) Jamb and casing/trim

9.11.3(e1) Acceptable sealers are paint, urethane, and varnish.

- Clear “water seal” products not allowed.
- Exterior-grade material must be used in exterior locations.

9.11.4 Hinges

9.11.4(a) Hinges shall:

9.11.4(a1) Conform to American National Standards Institute (ANSI)/Builders Hardware Manufacturers Association (BHMA) A156.1

9.11.4(a2) Be constructed of brass or stainless steel, minimum 0.120" thick

9.11.4(a3) Be loose-pin type unless mounted toward the exterior

9.11.4(a4) Be fixed-pin type when mounted toward the exterior

- A fixed pin is not required on the middle hinge.

9.11.4(b) 1⅜" doors require a minimum hinge size of 3½" x 3½".

9.11.4(c) 1¾" doors require a minimum hinge size of 4" x 4".

9.11.4(d) Hinges in firewall applications

9.11.4(d1) Minimum 3½" x 3½" spring-loaded with adjustable tension

9.11.4(d2) Adequate spring tension to make access cover self-closing

9.11.5 Screws to Attach Hinges

9.11.5(a) Wood and metal jambs: Brass or stainless steel flathead screws or as specified/ supplied by manufacturer

9.11.5(b) Pre-hung units and replacement jambs: Screws shall penetrate the trimmer stud at least ⅝".

9.12 Interior/Appliance Enclosure Doors and Hardware

9.12.1 Interior-grade, hinged, hollow-core, and louvered doors are allowed (e.g., for appliance enclosures and communication between rooms for combustion ventilation air).

9.12.2 Thickness: 1⅜" or 1¾"

9.12.3 Veneer: Minimum ⅛" thick

9.12.4 Hinges

9.12.4(a) Two or three hinges (three hinges for solid wood or solid core)

9.12.4(b) Constructed of brass or stainless steel

9.12.4(c) Conforming with ANSI/BHMA A156.1

9.12.4(d) Minimum hinge size: 3½" x 3½" and 0.120" thick.

9.12.5 Screws for hinges: Brass or stainless steel flathead screws

9.13 Mobile Home Swinging Exterior Replacement Doors

9.13.1 Doors must have:

9.13.1(a) Rigid stiles and rails (e.g., channel steel and/or wood)

9.13.1(b) Permanently finished skin (e.g., fiberglass or vinyl-clad metal)

9.13.2 Out-Swinging Doors

9.13.2(a) Must be pre-hung entrance doors manufactured for mobile homes

9.13.2(b) Must have a flanged metal frame (jambs, header, and sill) with integral weather seals (e.g., extruded flap vinyl, bulb seal, etc.)

9.13.3 In-Swinging “House-Type” Doors

9.13.3(a) Material and installation criteria for house-type doors installed in mobile homes are the same as those for conventional entrance doors.

9.13.3(b) The door blank may be installed independently if feasible.

9.13.3(c) A pre-hung unit may be installed when it is the best option.

9.14 Fireplace Chimney Damper

9.14.1 Factory-Built (Zero Clearance) Fireplaces

9.14.1(a) Repair or replacement parts shall be specified by the fireplace manufacturer.

9.14.2 Masonry Fireplaces

9.14.2(a) Commercially available top-sealing (chimney top) dampers

9.14.2(b) Sized to fit the chimney termination

9.14.2(c) Controllable from indoors (e.g., with a control cable inside the fireplace)

9.15 Fireplace Glass Doors

9.15.1 All glass doors shall:

9.15.1(a) Fit the smallest dimensions of the fireplace opening

9.15.1(b) Seal against the fireplace surface (e.g., with gasket or strips of fiberglass insulation)

9.15.1(c) Meet the requirements listed below based on fireplace type

9.15.2 Factory-Built (Zero Clearance) Fireplaces

9.15.2(a) Commercially available glass doors

9.15.2(b) Designed for use with zero clearance fireplaces

9.15.2(c) Sized and shaped to fit against and seal off the fireplace opening

9.15.3 Masonry Fireplaces

9.15.3(a) Commercially available glass doors

9.15.3(b) Designed for use with masonry fireplaces

9.15.3(c) Sized and shaped to fit against and seal off the fireplace opening

9.16 Sealants

9.16.1 All Materials

9.16.1(a) Contractor must comply with Proposition 65 requirements.

9.16.1(b) Exterior sealants will be durable, pest resistant, and provide a weather-appropriate seal.

9.16.2 Bond breaker tape shall:

9.16.2(a) Be polyethylene, polypropylene, PTFE, or closed-cell foam

9.16.2(b) Have self-adhesive backing.

9.16.3 Elastomeric joint sealant must be compliant with American Society of Testing and Materials (ASTM) C920

9.16.3(a) Includes polysulfide, polyurethane, and silicone

9.16.3(b) Neutral cure (oxime or alkoxy) sealants must be used for masonry applications.

9.16.4 Fire-resistant foam must be compliant with ASTM E814, UL 1479, or ASTM E84 Class 1.

9.16.4(a) Firestop or fireblock foam

9.16.4(b) Usually red or orange in color

9.16.5 Foam sealant must be:

9.16.5(a) UL-classified

9.16.5(b) Class A or Class 1 per ASTM E84

9.16.5(c) Minimally expanding

9.16.6 High-temperature caulk must be rated for constant service up to at least 450°F (e.g., room-temperature vulcanizing [RTV] red silicone available for service up to 600°F, such as automotive RTV gasket sealant).

9.16.7 Latex sealant must be compliant with ASTM C 834

9.16.7(a) Includes latex, acrylic latex, and siliconized acrylic

9.16.8 Solvent-release sealant must be compliant with ASTM C 1311

9.16.8(a) Includes acrylic, butyl rubber, and chlorosulfonated polyethylene

9.17 Wall or Shell Patching

9.17.1 Mesh Plumbing Patches

9.17.1(a) 28–30-gauge non-corrosive metal with self-adhesive backing

9.17.1(b) Backing shall be a strong pressure-sensitive adhesive film

9.17.1(c) Backing shall be reinforced with fiberglass mesh or equivalent

9.17.1(d) Patches shall be cut to fit snugly around pipes (e.g., pre-cut for installation around 2", 1½", ¾", and ½" pipes)

9.17.2 Finishing Compound

9.17.2(a) Lightweight, non-shrinking spackling compound or

9.17.2(b) Drywall joint compound or equivalent

9.17.3 Sheet Metal

9.17.3(a) Aluminum or galvanized sheet metal; minimum thickness 0.007"

9.17.4 Radiant Barrier Material

9.17.4(a) Commercially available foil/bubble/foil

9.17.4(b) Class A/Class 1, minimum thickness 5⁄16"

9.17.5 Foam Board

9.17.5(a) Polyisocyanurate foil–clad on both sides, ASTM C 1289 or Federal Standard (FS) HH-I-1972

9.18 Weatherstripping

9.18.1 Rigid gasket jamb materials (aluminum carrier)

9.18.1(a) Solid extruded aluminum carrier, 0.05" minimum nominal thickness

9.18.1(b) Pliable gasket of vinyl, TPE, silicone, or equivalent

9.18.1(c) The carrier shall have elongated mounting holes, 9" OC maximum

9.18.1(d) The secondary seal between the carrier and the mounting surface shall be a minimum of ⅛" wide and extend the full length of the carrier

9.18.2 Spring and Cushion Metal

9.18.2(a) Brass, bronze, or stainless steel only; aluminum is not allowed

9.18.3 Cushion Synthetic Pressure-Sensitive Door Gaskets

9.18.3(a) Polypropylene, TPE, silicone, or equivalent

9.18.3(b) L-shaped stabilizer with self-adhesive backing

9.18.4 Flanged bulb (Compression Bulb)

9.18.4(a) Pliable gasket of TPE or silicone (e.g., teardrop-shaped seal)

9.18.4(b) Minimum ⅜" wide with self-adhesive stabilizer flange

9.18.5 Round Tube

9.18.5(a) Pliable gasket of TPE, silicone, or equivalent

9.18.6 Foam Tape

9.18.6(a) The color shall be compatible with the surrounding materials (e.g., light-color foam for light-color surfaces).

9.18.6(b) Closed-cell foam tape shall be UV-resistant with self-adhesive backing.

9.18.6(c) Open-cell foam tape shall have self-adhesive backing.

9.18.7 V-Shape Fin Seal

9.18.7(a) Durable V-seal of silicone or equivalent material, with stabilizer flange and adhesive backing. (This is different from a vinyl V-strip.)

9.18.8 Replacement Kerf-In Bulb and Foam

9.18.8(a) Properly sized for the retaining channel

9.18.9 Replacement Pile

9.18.9(a) Fin seal type whenever feasible

9.18.9(b) Properly sized for the retaining channel

9.18.10 Corner Pads

9.18.10(a) Pile pad shall have self-adhesive backing

9.18.11 Mechanical Attachments

9.18.11(a) All screws, nails, staples, and other fasteners shall be:

9.18.11(a1) Non-corrosive metal

9.18.11(a2) Properly sized for each application

9.18.12 Pressure-Sensitive Adhesive

9.18.12(a) Minimum adhesion strength of 65 ounces per inch on all self-adhesive products

9.18.12(b) Required on all self-adhesive products

9.19 Window Repair

9.19.1 Replacement glass will be sized to the original width, height, and depth and comply with Table 32-7.

Table 32-7: Materials Requirements by Glass Type and Home Type

Glass Type	Maximum Pane Size	
	Conventional Home*	Mobile Home
Single-strength (SS): Allowed when double-strength glass is too thick for the frame	16 sq. ft.	11 sq. ft.
Double-strength (DS): Recommended to replace single-strength glass when the frame thickness is adequate	24 sq. ft.	15 sq. ft.
3⁄16" Plate Glass	45 sq. ft.	30 sq. ft.
¼" Plate Glass	65 sq. ft.	43 sq. ft.
Heat-Strengthened Glass	SS: 32 sq. ft. DS: 48 sq. ft. 3⁄16" plate: 90 sq. ft. ¼" plate: 130 sq. ft.	SS: 22 sq. ft. DS: 30 sq. ft. 3⁄16" plate: 60 sq. ft. ¼" plate: 86 sq. ft.
Fully Tempered Glass	SS: 64 sq. ft. DS: 96 sq. ft. 3⁄16" plate: 180 sq. ft. ¼" plate: 260 sq. ft.	SS: 44 sq. ft. DS: 60 sq. ft. 3⁄16" plate: 120 sq. ft. ¼" plate: 172 sq. ft.
*The listed glass sizing criteria are for installation in conventional home locations with low design pressure. For code requirements applicable to other locations, see chapter 24 of the current California Building Code or consult the local building department.		

9.19.2 Plastic Materials

9.19.2(a) All panes must be ultraviolet-treated polycarbonate, minimum ⅛" thick.

9.19.2(b) All sheeting must have sufficient rigidity to prevent bowing after installation.

9.19.2(c) Acrylic sheets and plastic film are not allowed.

9.19.3 Jalousie Windows

9.19.3(a) Minimum 3⁄16" glass will be installed.

9.19.3(b) Maximum pane length will be 48".

9.19.3(c) All attachment clips must be present.

9.19.3(d) Regular, patterned, frosted, tempered, and heat-strengthened glass is allowed.

9.19.3(e) Wired, laminated, and sandblasted glass is not allowed.

9.19.4 Safety glass must be:

9.19.4(a) Compliant with ANSI Z97.1

9.19.4(b) Permanently labeled per the current CRC

9.19.5 Glass Quality

9.19.5(a) The quality of the replacement glass will equal or exceed that of the existing glass.

9.19.6 Wood Casing/Trim

9.19.6(a) Use exterior-grade casing/trim in exterior locations.

9.19.6(b) Paint-grade casing/trim is acceptable unless the existing jamb has a natural finish.

10. WARRANTY

10.1 Manufacturer—One year on all products except as specified by the manufacturer or unless otherwise specified below

10.1.1 Caulk—10 years

10.1.2 Weatherstripping—3 years

10.2 Contractor—1 year

33. Windows & Sliding Glass Doors

Table of Contents

Windows & Sliding Glass Doors

1. MEASURE OBJECTIVES

1.1 New windows reduce solar heat gain, thermal transmission, and air infiltration.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable for this measure. See Section 32 Infiltration Reduction.

2.2. Install

2.2.1 The window or sliding glass door (SGD) separates a conditioned space from an unconditioned space and

2.2.2 Energy Efficiency Upgrade for the window or SGD has a savings-to-investment ratio (SIR) ≥1.0 as proven by an energy audit or

2.2.3 An individual window or SGD is documented to meet the CSD definition for catastrophic leakage per Appendix C Shell Leakage Test Protocol

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The window frame or glass can be repaired rather than replaced under Section 32 Infiltration Reduction

3.2 One or more of the following conditions exist and cannot be corrected within the program scope, which limits the home to non-infiltration measures only (the home is NIM):

3.2.1 A non-correctable environmental or combustion appliance safety (CAS) hazard or CAS fail exists under Appendix E Health and Safety Requirements, Environmental Hazards, or Appendix A Combustion Appliance Safety Protocol

3.2.2 Mechanical ventilation assessment/installation is required by contract but cannot be installed

3.2.3 The dwelling envelope is damaged or deteriorated, or the home is being remodeled, and the thermal boundary is incomplete beyond small infiltration gaps and cracks

3.3 Catastrophic leakage cannot be proven and documented, per Appendix C Shell Leakage Testing Protocol

3.4 Installation would violate the Appendix E Health and Safety Requirements

3.5 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 To prove catastrophic leakage, measurements and calculations of gap size for an individual window or SGD must be provided on the CSD 540 Dwelling Assessment Form.

4.1.2 Audited Measures

4.1.2 (a) When this measure will be installed under the Low Income Home Energy Assistance Program (LIHEAP) and an energy audit is performed, if the measure will be fully leveraged or co-funded, it must comply with Appendix D Energy Audit/Priority List Protocol.

4.1.2 (b) When this measure is paid for by LIHEAP, or is co-funded with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply.

4.1.3 Safety Glass

4.1.3(a) See Section 1 General Installation Guidelines, Safety Glass in Windows and Doors.

4.1.4 Egress Requirement

4.1.4(a) See Section 1 General Installation Guidelines, Window Egress (Conventional Homes).

4.2. Installation Procedure

4.2.1 The type of window replacement depends on the existing materials and an evaluation of the condition of the existing window (sash, jamb, sill, framing, etc.).

4.2.2 Installation procedures vary depending on the window replacement type.

4.2.3 When appropriate, masking tape or register film will be applied to existing broken panes to stabilize broken pieces and prevent them from falling out of the sash/frame during removal.

4.2.4 All mounting surfaces and contact areas must be smooth, clean, and free of protrusions.

4.2.5 The seal between the fixed components of the window (e.g., jambs, sill, exterior stops) will be continuous and complete while maintaining the operability of the window.

4.2.6 Windows shall be installed:

4.2.6(a) Plumb, level, and square with the sash edge parallel to the frame edge

4.2.6(b) With interior and exterior trim that provides a barrier to water and air infiltration and a finished appearance

4.2.7 Windows and doors will be adjusted to properly fit the jamb and allow for ease of operation and security.

4.2.8 Sash replacement (one or multiple window sashes replaced in an existing window frame)

4.2.8(a) Replace decayed or deteriorated sashes if a complete replacement window is not installed.

4.2.8(b) Existing weatherstripping and sash sealant will be removed.

4.2.8(c) Springs and sash weight systems must operate properly after sash replacement.

4.2.8(d) The lower sash must have the same bevel on the bottom rail as the sill.

4.2.8(e) The sash must be water-sealed and primed to prevent moisture intrusion.

4.2.8(f) The surface where the sill meets the sash will be cleaned.

4.2.8(g) Continuous and complete weatherstripping will be installed on the bottom of the lower sash where it makes contact with the sill and at the top of the upper sash where it makes contact with the upper part of the window frame.

4.2.8(h) Stops will be installed to keep the window securely in place and adjusted to eliminate visible gaps between the stops and the jamb while maintaining operability of the window.

4.2.8(i) Sash locks shall be installed and adjusted so that the rails of the upper and lower sashes are flush and in full contact with no visible gaps.

4.2.9 Retrofit Replacement Window into an Existing Frame

4.2.9(a) “Box frame” windows (also known as “insert” or “pocket replacement” windows) can be installed into an existing window frame when the frame and sill are structurally sound and no moisture damage or rot is evident.

4.2.9(a1) Interior and exterior trim/casing usually will not be disturbed.

4.2.9(b) “Flush fin” windows are similar to box frame windows except they have an exterior flange that conceals the perimeter of the existing window opening and trim. This type of window is typically used when replacing metal frame windows. New interior trim/casing is usually required.

4.2.9(c) Preparation of the opening

4.2.9(c1) All frames

- All existing components associated with the installation must be structurally sound.

- Water penetration points must be sealed.
- All necessary repairs shall be made to facilitate the installation of the replacement unit.

4.2.9(c2) Wood frames

- Remove and repair any decayed material and clean the opening before the new window is installed.
- The existing frame must be securely attached in the rough opening.

4.2.9(c3) Metal frames

- Remove sashes, screens, and hardware from the frame (Fig. 33-1).
- The maximum rough opening should be maintained by cutting away the metal frame as needed. See Section 1 General Installation Guidelines, Window Egress (Conventional Homes).
- Remove or correct any burrs, sharp corners and edges, and other such hazards.

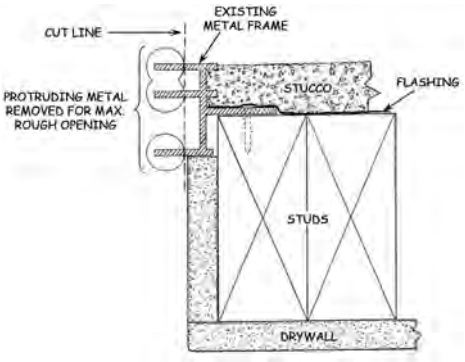


FIG. 33-1: METAL WINDOW FRAME INSTALLATION

4.2.9(d) Window installation

4.2.9(d1) Bottom support

- The sill jamb of the replacement window must not rest directly on anything that would cause damage (e.g., the sharp edge of the original aluminum frame).

4.2.9(d2) Clearances

- Between the window and the rough opening, ensure side and top clearances conform to the manufacturer's specifications.
- Between the exterior of the window and the siding, provide clearances as specified by the manufacturer and fill spaces with caulk.

4.2.9(d3) Attachment

- Do not anchor the top to the header unless prescribed by the manufacturer.
- When large windows must be secured at the top, allowance must be made for flexing and sagging of the header.
- Anchors must be corrosion-resistant and compatible with the materials they contact/penetrate.
- Screws must penetrate solid wood at least ⅝".
- Anchors for vinyl windows must be placed at least 10" from corners or per manufacturer instructions.
- Installing flush fin retrofit windows (Fig. 33-2)
  - Install the fin over the exterior surface (e.g. stucco, siding).
  - Anchor the frame to the structural framing with non-corrosive #8 or larger screws.
  - Do not:
    - Place screws in the fin
    - Attach the retrofit frame to the old window frame

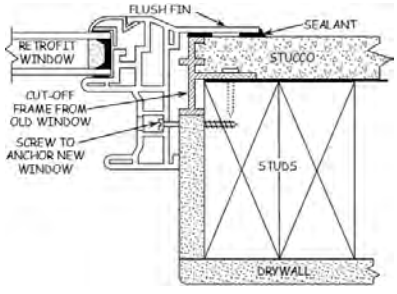


FIG. 33-2: FLUSH FIN WINDOW INSTALLATION

4.2.9(d4) Closure at the bottom (Fig. 33-3)

- The beveled sill will be flush with the interior wall and sloped to the exterior.

- Install a step sill, step extender, or equivalent when the gap between the existing sill and the new sill jamb exceeds ¼".
- Seal the bottom of the unit except for small gap(s) near the center (for drainage).

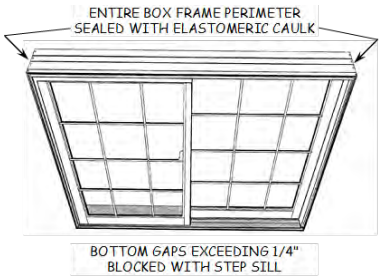


FIG. 33-3: BOX FRAME WINDOW BOTTOM CLOSURE

4.2.9(d5) Buildout (jamb extension)

- Extend (build out) the window frame when it is narrower than the wall thickness.
- Buildout material must be compatible with the frame material and be finished to match the frame.

4.2.10 Full-Frame Replacement Windows (Existing Frame Removed)

4.2.10(a) When the existing window frame, jamb, sill, and/or rough framing show signs of water leaks, rot, or other damage, the entire window unit must be removed down to the rough opening. A complete window assembly is installed, including new window frame, sill, and nailing fin for attachment of the window unit to the framing. New interior and exterior trim/casing is required.

4.2.10(b) Preparation of the opening

4.2.10(b1) Remove the old window frame and all obstructions, such as nailing fins, nails, and hardware, from the rough opening.

4.2.10(b2) Remove the exterior trim or cut back the exterior siding to fit the new window frame and trim. Replace all decayed material to ensure the framing is structurally sound.

4.2.10(c) Additional preparation of the opening for an SGD

4.2.10(c1) Remove the existing door frame, anchors, and sealant.

4.2.10(c2) The opening must be structurally sound, square, plumb, and level.

- Seal water penetration points.
- Provide sound anchorage for the replacement unit.
- Ensure the floor is structurally adequate to properly support the replacement sill in a level condition.

4.2.10(c3) The tread under the door or landing surface must be no less than 9" in depth (Fig. 33-4).

4.2.10(c4) Insulate gaps between the door frame and the rough opening with mineral fiber or backer rod.

- If minimally expanding foam is used, it must be installed properly to avoid warping the frame.

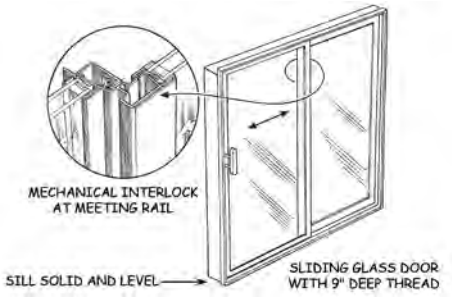


FIG. 33-4: SGD ATTRIBUTES

4.2.10(c5) The threshold will be installed a maximum height of 1" above the interior floor surface.

- When the occupant is physically handicapped, extend the threshold above the interior finished floor surface a maximum of ½".

4.2.10(d) Full-frame replacement window and SGD installation

4.2.10(d1) The mounting detail will be determined based on the depth of the window and the location of the window liner.

4.2.10(d2) Shims

- Install shims as required to:
  - Ensure square installation and proper operation of sashes
  - Minimize distortion or rotation of the frame or sill

- The sill jamb must be uniformly supported with doubled shims (Fig. 33-5).
  - Double-up tapered shims (one on top of the other, facing in opposite directions).
- Shims used to establish spacing at anchor points must be:
  - Penetrated by the anchor
  - Trimmed as needed but not removed
- Temporary shims in other locations can be removed after the window is securely anchored (Fig. 33-6).

FIG. 33-5: INSTALLING SHIMS TO MAINTAIN REQUIRED CLEARANCE

4.2.10(d3) Clearances

- Between the window and the rough opening, ensure side and top clearances conform to the manufacturer's specifications.
- Between the exterior of the window and the siding, provide clearances as specified by the manufacturer and fill spaces with caulk.

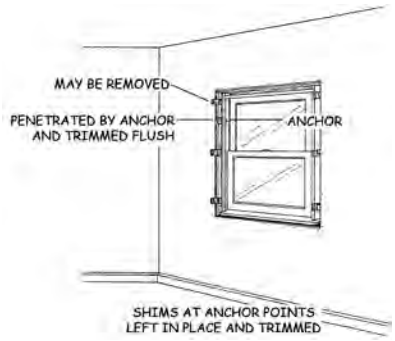


FIG. 33-6: SHIM INSTALLATION AT ANCHOR POINTS

4.2.10(d4) Attachment

- Do not anchor the top to the header unless prescribed by the manufacturer.
- When large windows must be secured at the top, allowance must be made for flexing and sagging of the header.
- Anchors
  - Anchors must be corrosion-resistant and compatible with the materials they contact/penetrate.
  - Nails must penetrate solid wood at least ¾".
  - Screws must penetrate solid wood at least ⅝".
  - Anchors for vinyl windows must be placed at least 10" from corners or per the manufacturer.

4.2.10(d5) Flashing and drip cap

- Install flashing per the window manufacturer's instructions (Fig. 33-7):
  - When the fins are attached directly to the sheathing or framing
  - When the windows are not secured by fins, but the existing flashing is damaged
- Install a drip cap when recommended by the window manufacturer to direct rain water away from the top of the window.

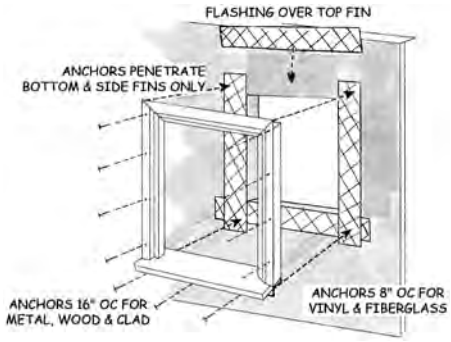


FIG. 33-7: ATTACHMENT AND FLASHING REQUIREMENTS FOR FULL-FRAME REPLACEMENT WINDOWS

4.2.10(d6) Cavity insulation

- Insulate open cavities between the rough framing and the window jamb (Fig. 33-8).
  - Exception: Do not insulate cavities where window weights are being utilized.

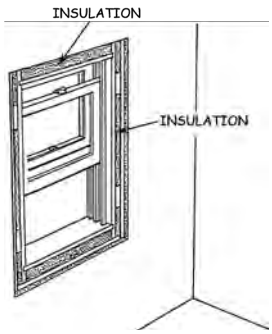


FIG. 33-8: CAVITY INSULATION

4.2.10(d7) Additional procedures—SGDs

- Header, jambs, and sill
  - The jambs and header must be flashed and sealed as prescribed for the SGD replacement type.
  - Protect aluminum sills from contact with corrosives such as concrete, stucco, and steel (e.g., with sill pan or wood).
  - Support the sill (e.g., with shims or solid wood) to prevent sagging or twisting during door operation.
  - Apply two continuous, parallel, ⅜" nominal beads of elastomeric sealant to the entire length of the rough sill and 6" up each jamb into which the door sill or the sill pan is set.
  - When the door is set into a sill pan, apply a continuous sealant bead along the upturned leg of the sill pan. Also apply a bead of sealant near the front of the pan where the door sill makes contact, leaving gaps in the bead for water to escape.
- Install the door square, level, and plumb and secure it through pre-drilled holes placed 3"–10" from each corner and 16" on center (OC) or as prescribed by the manufacturer.
- Flanged SGDs
  - Position the replacement mounting flange to cover holes created by the pre-existing door.
  - Apply elastomeric caulk or non-hardening sealant/putty tape to the back of the mounting flange.
  - The sill must rest on the floor or have solid support from jamb to jamb.
  - Center the unit side-to-side in the opening, with the sides plumb and the frame square.
  - Securely anchor the flange with screws spaced in accordance with the manufacturer's instructions.

4.2.11 Window Sealing

4.2.11(a) Exterior sealing

4.2.11(a1) Seal windows and SGDs with elastomeric caulk.

4.2.11(a2) Cracks wider than ⅝" must be repaired, not caulked.

4.2.11(a3) Before caulking, fill cracks ¼"–⅝" wide to within ½" of the surface with closed cell polyethylene rod or mineral fiber insulation.

4.2.11(a4) Dissimilar metals must be separated from each other with a non-conductive tape, coating, or sealant material.

4.2.11(a5) Flanged windows

- Caulk the window flange or frame perimeter to ensure a watertight seal.

4.2.11(a6) Block frame windows

- Caulk the entire exterior perimeter to ensure a watertight seal.

4.2.11(a7) Under fins

- Place a generous bead of caulk between the fins and the mounting surface.
- Ensure the sealant bead is continuous except for small gap(s) near the center of the bottom fin (for drainage).

4.2.11 (a8) Around the casing perimeter

- Caulk the joint (gap) where the casing and siding meet except for small gap(s) near the center of the bottom trim (for drainage).

4.2.11 (a9) Between the window frame and the siding (no casing)

- Caulk the seam (gap) between the frame and the siding.

4.2.11 (b) Wood frame sealing materials

4.2.11 (b1) Prime all bare wood on the exterior per manufacturer's instructions and industry standards to prevent moisture damage (Fig. 33-9).

4.2.11 (b2) Lap the finish coat 1/16" onto the glass for a proper moisture seal.

4.2.11 (b3) Do not apply paint to weatherstripping, vinyl, plastic, and other non-wood parts unless specifically allowed by the manufacturer.

4.2.11 (b4) Acceptable sealers are paint, urethane, and varnish.

4.2.11 (b5) Exterior-grade material (e.g., high-quality oil-based or latex paint) is required in exterior locations.

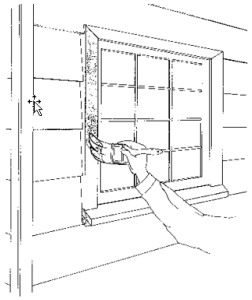


FIG. 33-9: PAINT OR PRIME ALL BARE WOOD ON EXTERIOR FRAME

4.2.11 (c) Interior sealing

4.2.11 (c1) Seal the gap between the window frame and the rough opening with elastomeric caulk.

4.2.11 (c2) Sealant must be applied before the casing/trim is installed and may also be applied around the outside of the casing/trim.

4.2.11 (c3) Wood frame sealing materials

- Prime or stain interior surfaces in accordance with manufacturer instructions.

4.2.12 Casing/Trim

4.2.12 (a) Install sealant on the interior and exterior of all units (except on flush fin retrofit windows) (Fig. 33-10).

4.2.12 (b) Wood casing/trim

4.2.12 (b1) Paint-grade sealant is acceptable unless the existing jamb has a natural finish.

4.2.12 (b2) Exterior-grade sealant is required in all exterior locations.

4.2.12 (b3) The existing casing and miters must be matched.

4.2.12 (b4) Nails

- Finishing or casing nails are required for interior applications.
- Galvanized casing nails are required for exterior applications.

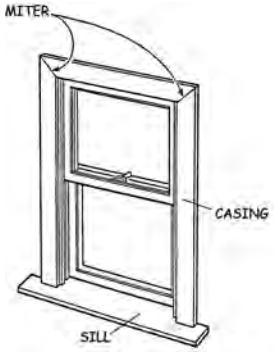


FIG. 33-10: CASING/TRIM

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation of windows and SGDs in mobile homes is the same as conventional homes except as specified below.

5.1.1 (a) Windows shall not be installed in mobile homes when:

5.1.1 (a1) Window or SGD replacement requires removal of siding

5.1.1 (a2) An open combustion gas-burning space heater or water heater that draws combustion air from the living space is present

5.1.1 (a3) An open combustion solid-fuel burning space heater (i.e., fireplace, insert, wood stove) that draws combustion air from the living space is present

- Exception: Pressure diagnostics and infiltration-reduction measures will be allowed when:
  - Pressure measurement shows the combustion appliance zone (CAZ) of each appliance is less negative than the house depressurization limit (HDL) and
  - Installed measures do not depressurize the CAZ beyond the HDL.
    - See procedures described in Appendix A Combustion Appliance Safety Protocol.

5.1.1 (b) Mobile Home Egress Windows

5.1.1 (b1) See Section 1 General Installation Guidelines, Window Egress (Mobile Homes).

5.1.1 (b2) Screws anchoring into the framing structure of the mobile home must penetrate wood at least ¾".

5.1.1 (b3) Attachment of flanged windows (Fig. 33-11)

- Place screws within 4" of each corner.
- For metal frames:
  - Place additional screws a maximum of 12" apart.
  - Use a minimum of three screws on each side exceeding 18" in length.
- For vinyl frames:
  - Place additional screws a maximum of 8" apart.
  - Use a minimum of three screws on each side exceeding 14" in length.

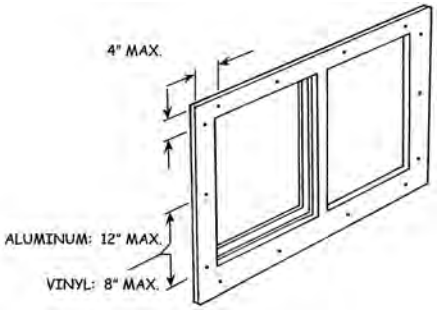


FIG. 33-11: ATTACHMENT OF FLANGED WINDOWS

5.1.1 (b4) Attachment of box frame windows (no flange)

- Secure the window in place with screws and/or stops fastened to the rough opening.
- Install screws perpendicular to the window frame.
  - Do not angle screws to pull the window into the rough opening.
- Install flashing at the top of the window.
- Install drip cap in all locations not protected by an awning or porch.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes except as specified below.

6.1.1 (a) Window or SGD Energy Efficiency Upgrades are not allowed for individual units in a multi-family building.

6.1.1 (b) Replacement of an individual window or SGD for catastrophic leakage in an individual unit in a multi-family building will only be allowed under LIHEAP.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.2 (a) Whole-building window or SGD Energy Efficiency Upgrades must be justified in an energy audit with an SIR ≥1.0 per Appendix D Energy Audit/Priority List Protocol.

6.1.3 Common area installations (e.g., in a lobby, waiting area, entertainment room, etc. within the same thermal boundary as dwelling units) are allowed when justified by energy audit for a whole-building project per Appendix D Energy Audit/Priority List Protocol.

6.1.3(a) Common area installation is not allowed when only an individual unit in a multi-family building will be served.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 Window/SGD repair is only allowed when justified as an incidental repair.

7.1.2 Window/SGD replacement shall not be performed as an infiltration reduction measure.

7.1.3 To install this measure with DOE funding as an energy efficiency upgrade, use of the Priority List (PL) or a site-specific energy audit is required, or it may be justified as an incidental repair.

7.1.3(a) Window repair/replacement to correct catastrophic leakage is not allowed.

7.1.4 To assess for this measure as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.4(a) The form will determine if the measure will be installed in the Audit path or the PL path.

7.1.4(b) When assessing for this measure for the Audit path, measure feasibility will be decided by the energy audit with a Measure savings-to-investment ratio (SIR) and Dwelling SIR.

7.1.4(c) When assessing for the measure in the PL path, the feasibility will be based on building type and characteristics.

7.1.4(c1) PL measures are classified as Mandatory or Optional based on building type.

- Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.
- Optional measures may be installed only after all feasible Mandatory PL measures have been installed.

7.1.4(c2) This measure shall be applied to the PL only in mobile homes with propane or oil-fired primary heat. It shall not apply for other building types.

7.1.4(c3) If an energy conservation measure is not present on the PL for a specific building type, a site-specific energy audit with all feasible measures shall be conducted.

7.1.5 If a client refuses a feasible Audit path Major measure, Mandatory Priority List path, or Health & Safety measure, the entire dwelling shall be deferred.

7.1.6 When this measure is fully leveraged or co-funded with LIHEAP, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/ Priority List Protocol.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Perform post-installation CAS testing of open-combustion appliances that draw combustion air from the living space. See Appendix A Combustion Appliance Safety Protocol.

8.1.2 Window and SGD units shall operate smoothly.

8.1.3 The frame shall be square so sashes/panels close properly at all corners and edges (Fig. 33-12).

8.1.4 Interlocks and latches must function properly.

8.1.5 Clean all replacement window and SGD glass inside and out.

8.2. Client Education

8.2.1 Supply the client with both verbal and written instructions for:

8.2.1(a) Proper operations and maintenance

8.2.1(b) Safety considerations

8.2.1(c) Warranty

8.3. Clean-Up and Disposal Requirements

8.3.1 Remove all replaced windows, SGDs, broken glass, debris, and other miscellaneous parts from the property and dispose of them properly.

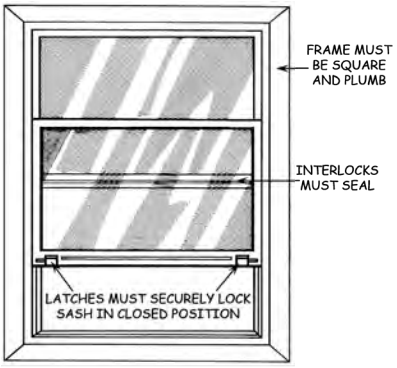


FIG. 33-12: POST-INSTALLATION QUALITY CHECK

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 20 years

9.1.2 DOE: 20 years

9.2 All replacement window and SGD materials shall be:

9.2.1 ENERGY STAR®–certified

9.2.2 Compliant with local code and bear an National Fenestration Rating Council (NFRC) temporary label

9.2.3 Compliant with the warranty requirements below

9.2.4 Compliant with the following Title 24 energy efficiency standards:

9.2.4(a) U-Factor in all California Energy Commission (CEC) climate zones: Maximum 0.30

9.2.4(b) Solar heat gain coefficient:

9.2.4(b1) CEC climate zones 1, 3, 5, 16: No requirement

9.2.4(b2) CEC climate zones 2, 4, 6–15: Maximum 0.23

9.2.5 Selected by type in accordance with Table 33-1:

TABLE 33-1: REPLACEMENT WINDOWS BY TYPE

Existing Window Type	Replacement Window Type
Horizontal slider	Horizontal slider
Vertical slider	Vertical or horizontal slider
Picture window	Picture or sliding window
Jalousie window	Vertical or horizontal slider

9.3 Mobile home windows and SGDs shall be designed for manufactured home use.

9.3.1 Egress windows must be labeled to show they comply with the Code of Federal Regulations (CFR) Title 24 3280.404 and American Architectural Manufacturers Association (AAMA) 1704.

9.4 An SGD must have an interlock at the meeting rail.

9.5 Openable windows must have insect screens.

9.6 Exterior wooden stop and casing materials must be exterior-grade.

9.7 Sealing materials:

9.7.1 Caulk

9.7.1(a) The contractor must comply with Proposition 65 requirements.

9.7.1(b) Sealants applied indoors must be non-toxic.

9.7.2 Solvent release sealants include acrylic, butyl rubber, and chlorosulfonated polyethylene and must conform to American Society for Testing and Materials (ASTM) C1311.

9.7.3 Latex sealants include latex, acrylic latex, and siliconized acrylic and must conform to ASTM C834.

9.7.4 Elastomeric joint sealants include polysulfide, polyurethane, and silicone and must conform to ASTM C920 or other ASTM standards for elastomeric sealants (e.g., C603, C734, C1250, and D2202).

9.7.5 Foam sealants must be:

9.7.5(a) Used only when specified by the window manufacturer

9.7.5(b) Minimally expanding

9.7.5(c) Class A or Class 1 per ASTM E84

9.7.5(d) Fire-resistant foam compliant with ASTM E814 or Underwriters Laboratories (UL) 1479

9.8 Attachment materials:

9.8.1 Screws must be non-corrosive #8 or larger.

10. WARRANTY

10.1 Manufacturer—10 years (insulated glass unit [IGU])/3 years (other)

10.2 Contractor—1 year

34. Storm Windows

Table of Contents

Storm Windows

1. MEASURE OBJECTIVES

1.1 Storm windows improve the thermal insulation of existing windows.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure

2.2. Install

2.2.1 The window or sliding glass door separates a conditioned space from an unconditioned space

2.2.2 The primary window is a single-paned type and is intact

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The existing storm window functions properly

3.2 The existing primary window is a dual-pane type or the window unit will be replaced with a dual-pane window under Section 33 Windows and Sliding Glass Doors

3.3 The primary window is in a sleeping room and would not meet egress requirements with a storm window installed. (See Section 1 General Installation Guidelines, Window Egress (Conventional Homes).

3.4 The primary window is damaged and cannot be repaired. Refer to Section 32 Infiltration Reduction.

3.5 The window has tinted glass or window film

3.6 One or more of the following conditions exist and cannot be corrected within the program scope, which limits the home to non-infiltration measures only (the home is NIM):

3.6.1 A non-correctable environmental or combustion appliance safety (CAS) hazard or CAS fail exists under Appendix E Health and Safety Requirements, Environmental Hazards, or Appendix A Combustion Appliance Safety Protocol

3.6.2 Mechanical ventilation assessment/installation is required by contract but cannot be installed

3.6.3 The dwelling envelope is damaged or deteriorated, or the home is being remodeled, and the thermal boundary is incomplete beyond small infiltration gaps and cracks

3.7 Installation would violate the Appendix E Health and Safety Requirements

3.8 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 All existing components associated with the primary window must be structurally sound.

4.1.2 All mounting surface contact areas must be smooth, clean, and free of protrusions.

4.1.3 Sealant is required on all bare wood, except redwood, before installation of the storm unit.

4.1.4 Attachment of the storm window shall in no way impede the proper operation of the primary window.

4.1.5 Safety Glass

4.1.5(a) See Section 1 General Installation Guidelines, Safety Glass in Windows and Doors.

4.1.6 Egress Requirement

4.1.6(a) See Section 1 General Installation Guidelines, Window Egress (Conventional Homes).

4.2. Installation Procedures

4.2.1 Storm Window Type, Size, and Shape

4.2.1(a) The type, size, and shape of the storm window shall match the primary window (Fig. 34-1).

4.2.1(b) Storm window frames, grids, and meeting rails shall align with those of the primary window.

4.2.1(c) Storm windows built for interior use must be installed only on the interior.

4.2.1(d) Storm windows built for exterior use must be installed only on the exterior.

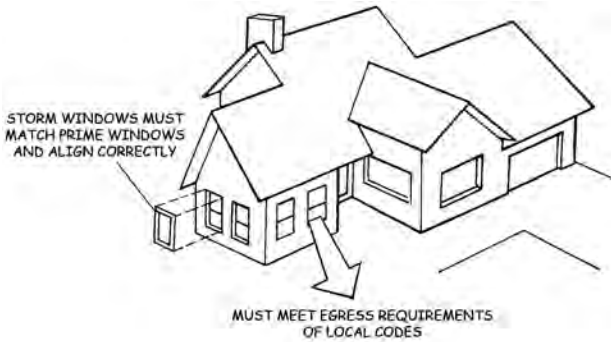


FIG. 34-1: STORM WINDOW WILL MATCH PRIMARY WINDOW

4.2.2 Sash Requirements

4.2.2(a) Windows must be constructed to allow easy and accessible removal of movable lites and fixed sash panels for cleaning, “set-aside” storage, and egress.

4.2.2(a1) Removal must not require special tools.

4.2.2(b) All operable windows must be operable from inside the home.

4.2.2(c) All removable lites and sash panels must be free of sharp edges or other conditions that could cause injury during normal use.

4.2.2(d) Sash travel must be controlled to prevent free fall.

4.2.2(e) All vertical sliders shall be equipped with one of the following:

4.2.2(e1) An automatic “sash lock” mechanism that stops at the next lower latch position when the sash is allowed to drop (Fig. 34-2)

4.2.2(e2) A pressure/friction system that will effectively prevent free fall

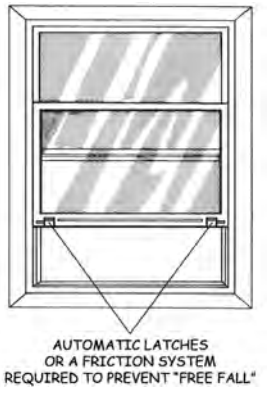


FIG. 34-2: SASH REQUIREMENTS

4.2.3 Weepage System

4.2.3(a) A weepage system shall be provided on exterior storm windows (Fig. 34-3).

4.2.3(a1) There will be a minimum of two weep holes per track.

4.2.3(a2) The holes will be a minimum of ⅛" diameter or equivalent.

4.2.4 Thermal Barrier

4.2.4(a) A non-corrosive thermal barrier must be installed to prevent metal-to-metal contact between primary windows and storm units.

4.2.4(a1) The barrier must be minimum ⅛" thick glazing tape, gasket, or elastomeric material.

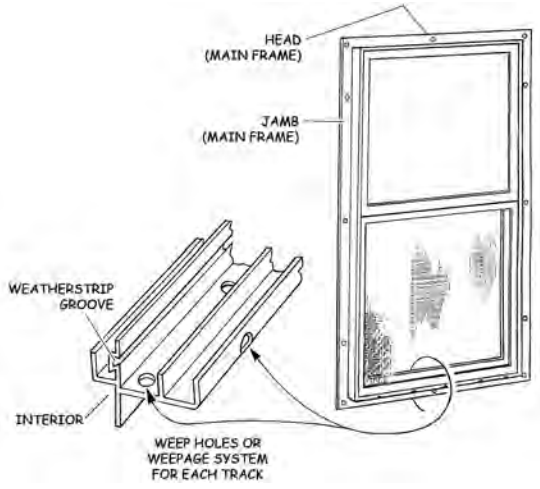


FIG. 34-3: WEEPAGE SYSTEM

4.2.5 Air Sealing

4.2.5(a) All storm windows

4.2.5(a1) All framed storm units must be installed with a permanent, airtight seal between the storm frame and the mounting surface (Fig. 34-4).

4.2.5(a2) Sealants must be resilient, non-hardening, long-life materials.

4.2.5(a3) All joints and gaps over 1/32" must be sealed.

4.2.5(a4) All exterior attachment penetrations must be watertight.

4.2.5(a5) Weep holes must not be sealed.

4.2.5(b) Framed interior storm windows

4.2.5(b1) Install the frame using glazing tape, caulking, or other effective sealant between the storm frame and the mounting surface so that a complete and permanent seal is provided around the entire perimeter of the storm window.

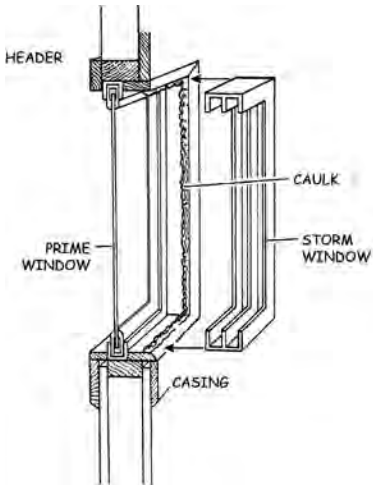


Fig. 34-4: Caulking Used for Air Sealing

4.2.5(c) Unframed interior storm windows

4.2.5(c1) Seal the mounting surface with minimum 1/8"-thick, closed cell foam tape or equivalent.

4.2.5(c2) Panels attached with continuous magnetic strips require no additional gaskets if the attachment system provides an airtight seal.

4.2.6 Air Space

4.2.6(a) The space between the storm windows and primary windows must be between 1/2"–4" (Fig. 34-5).

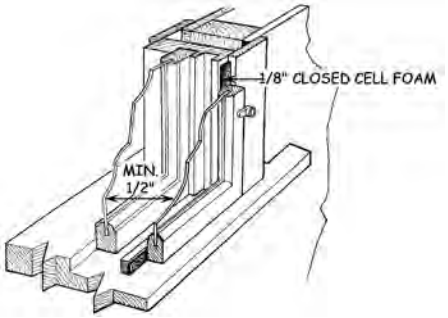


Fig. 34-5: Air Space Requirements

4.2.7 Primary Window Operation

4.2.7(a) Permanently mounted "self-storing" operable storm windows

4.2.7(a1) Opening primary windows must remain operable without removal of the storm window sash or frame.

4.2.7(a2) Interior access to primary window latches must not be impaired.

4.2.8 Preparation of Opening

4.2.8(a) All existing components associated with the installation shall be structurally sound.

4.2.8(b) All necessary repairs shall be made to facilitate installation of the storm window.

4.2.8(c) Water penetration points must be sealed.

4.2.8(d) All mounting surfaces must be smooth and clean.

4.2.9 Exterior Storm Window Attachment

4.2.9(a) Permanently anchor exterior frames with corrosion-resistant screws per the manufacturer's instructions or the following guidelines, whichever is more stringent (Fig. 34-6).

4.2.9(b) All frames shall have screws placed within 4" of each corner.

4.2.9(b1) For wood frames, screws anchoring into solid wood must penetrate the wood at least ¾".

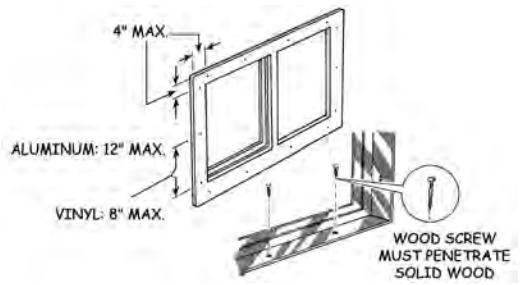


Fig. 34-6: Exterior Storm Window Attachment

4.2.9(b2) For metal frames:

- Place additional screws a maximum of 12" apart
- Use a minimum of three screws on each side that exceeds 18" in length

4.2.9(b3) For vinyl frames:

- Place additional screws a maximum of 8" apart
- Use a minimum of three screws on each side that exceeds 14" in length

4.2.10 Interior Storm Window Attachment

4.2.10(a) Framed interior storm windows

4.2.10(a1) Install framed interior storm windows with mounting fins as prescribed above for exterior storm windows.

4.2.10(a2) Securely attach block frame windows (without fins) within the primary window opening with screws.

- Use a minimum of two screws per jamb for pre-assembled frames.
- Use a minimum of two screws per piece when the jambs, header, and sill are independent.

4.2.10(a3) Install shims as needed to prevent torquing or warping the frame.

4.2.10(b) Unframed fixed interior storm windows (applies to windows not in egress locations)

4.2.10(b1) When secured with rotating clips, locate clips within 4" of each corner and elsewhere, as needed, to provide a tight seal around the entire sash perimeter (Fig. 34-7).

4.2.10(b2) When secured with magnetic strips, attachments must be permanently bonded to the sash and mounting surface and have sufficient holding strength to retain the panel securely and maintain an airtight seal (Fig. 34-8).

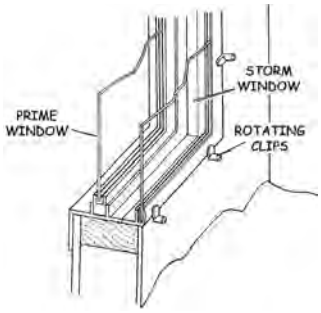


Fig. 34-7: Interior Storm Window Secured with Rotating Clips

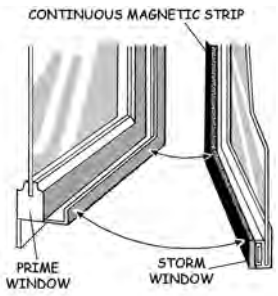


Fig. 34-8: Interior Storm Window Secured with Magnetic Strip

4.2.10(c) Sash-mount storm windows (Fig. 34-9)

4.2.10(c1) The storm sash must be securely attached to the primary sash with screws within 4" of each corner and elsewhere as required to create a complete seal.

4.2.10(c2) The perimeter of the storm sash must be made airtight with sealant or weatherstripping.

4.2.10(c3) There must be a minimum ½" air space between storm windows and primary windows.

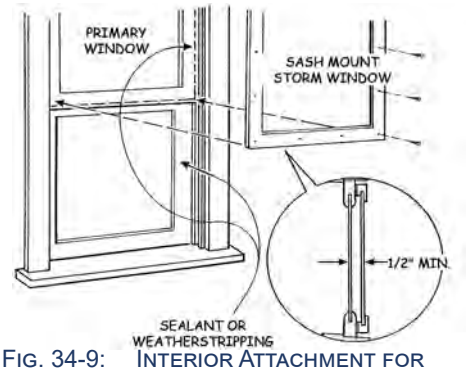


Fig. 34-9: Interior Attachment for Sash-Mount Storm Windows

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

5.1.2 Storm windows shall not be installed in mobile homes when:

5.1.2(a) An open combustion solid-fuel burning space heater (i.e., fireplace, insert, wood stove) that draws combustion air from the living space is present

5.1.2(a1) Exception: Pressure diagnostics and infiltration-reduction measures will be allowed when:

- Pressure measurement shows the combustion appliance zone (CAZ) of each appliance is less negative than the house depressurization limit (HDL) and
- Installed measures do not depressurize the CAZ beyond the HDL
  - See procedures described in Appendix A Combustion Appliance Safety Protocol.

5.1.3 Installations shall conform with Housing and Urban Development (HUD) Manufactured Home Construction and Safety Standards (MHCSS), the California Code of Regulations for Mobile Homes, and Housing and Community Development (HCD) code.

5.1.4 Mobile Home Storm Window Egress Requirements

5.1.4(a) See Section 1 General Installation Guidelines, Window Egress (Mobile Homes).

5.1.5 Operable Interior and Exterior Storm Windows

5.1.5(a) The horizontal or vertical force required to open the window for egress must not exceed 20 lbs.

5.1.5(b) Windows must have no more than two locks or latches that require operation to achieve egress.

5.1.6 Fixed Storm Windows

5.1.6(a) Windows must be installed only on the interior.

5.1.6(b) Removable lites and panels (with or without sash) that require set-aside for egress must:

5.1.6(b1) Have a maximum weight of 20 lbs.

5.1.6(b2) Be removable by application of force not to exceed 20 lbs.

5.1.6(c) Storm windows that are held in place with pivot or swivel devices (rotating clips) must have no more than four such devices requiring operation for egress (Fig. 34-10).

5.1.6(c1) Rotating clips must be placed a maximum of 54" above the floor.

5.1.6(c2) Rotating clips must turn to open by application of force not exceeding 5 lbs.

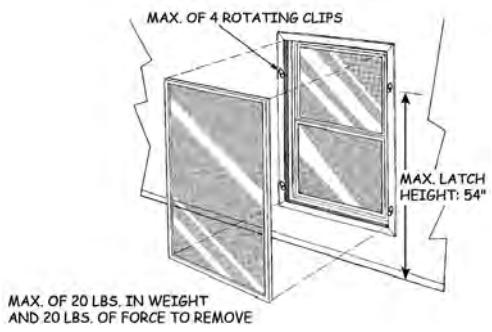


FIG. 34-10: MOBILE HOME FIXED STORM WINDOWS

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 There are no multi-family whole-building installation requirements. The conventional home (single-family) criteria apply to all multi-family whole-building installations.

6.1.3 When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.3(a) Common area installation (e.g., in a lobby, entertainment room, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Perform post-installation CAS testing of open-combustion appliances that draw combustion air from the living space. See Appendix A Combustion Appliance Safety Protocol.

8.2. Client Education

8.2.1 The client must be provided with both written and verbal instructions for the safe operation and/or removal of all storm windows installed in egress locations.

8.2.1(a) Instructions must be in a durable form (e.g., a permanent instruction label attached to the window, or an instruction card printed on card stock).

8.2.2 The client must be notified of changes or repairs made and be educated on how to operate and maintain storm windows, weatherstripping, and caulk around windows and trim.

8.3. Clean-Up and Disposal Requirements

8.3.1 Installation debris shall be removed from the property and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 10 years

9.1.2 DOE: Not applicable to this measure

9.2 Storm Window Frame

9.2.1 Aluminum frame windows must conform to American National Standards Institute (ANSI)/ American Architectural Manufacturers Association (AAMA) 1002.10.

9.2.2 Wood frame windows must conform to Section 3 of ANSI/National Wood Window and Door Association (NWWDA) I.S.2.

9.2.3 Rigid vinyl frame windows must be ultraviolet (UV)-resistant and conform to American Society of Testing and Materials (ASTM) standards.

9.3 Storm Window Glazing

9.3.1 Glass must conform to ASTM C1036 Standard Specification for Flat Glass for conventional homes and AAMA 1701.2 for mobile homes.

9.3.2 Polished wire glass must conform to ANSI Z97.1.

9.3.3 Safety glass must conform to ANSI Z97.1 and be permanently labeled.

9.3.4 Plastic glazing must:

9.3.4(a) Be UV- and scratch-resistant polycarbonate

9.3.4(b) Be a minimum of ⅛" thick

9.3.4(c) Conform to ANSI Z97.1

9.3.5 Glass Selection

9.3.5(a) Conventional home

9.3.5(a1) Glass shall be selected in accordance with the currently adopted California Residential Code (CRC).

9.3.5(a2) The maximum pane size for each frame type and thickness of glass must be as specified in Table 34-1 unless location-specific requirements of the CRC are more restrictive.

TABLE 34-1: GLASS THICKNESS

Glass Thickness	Maximum Glass Size	
	Aluminum or Wood Frame	Rigid Vinyl Frame
Single strength	16 sq. ft.	Not allowed
Double strength	24 sq. ft.	17 sq. ft.*
3⁄16" plate	45 sq. ft.	25 sq. ft.
¼" plate	65 sq. ft.	Not allowed
*Vertical measurement shall not exceed 4'.		

9.3.5(b) Mobile home

9.3.5(b1) The maximum pane size for each frame type and thickness of glass will be as specified in Table 34-2.

TABLE 34-2: GLASS THICKNESS—MOBILE HOMES

Glass Thickness	Maximum Glass Size	
	Aluminum or Wood Frame	Rigid Vinyl Frame
Single strength	11 sq. ft.	Not allowed
Double strength	15 sq. ft.	15 sq. ft.**
3⁄16" plate	30 sq. ft.	25 sq. ft.
¼" plate	43 sq. ft.	Not allowed
**Vertical measurement shall not exceed 4'.		

9.4 Hardware and fasteners must be aluminum, stainless steel, or other non-corrosive material compatible with the frame.

9.5 Angled Corners (Rake Windows)

9.5.1 Frame corners shall be metal.

9.5.2 Adjustable internal frame corners are allowed.

9.5.2(a) Durable, solid plastic (two legs riveted in the center) is acceptable when adjustable metal frame corners are not available.

9.6 Sealants

9.6.1 Glazing tape must:

9.6.1(a) Be closed cell foam

9.6.1(b) Be a minimum of ⅛" thick

9.6.1(c) Conform to ASTM C509

9.6.2 Pre-formed gaskets must conform to ASTM C509.

9.6.3 Caulk

9.6.3(a) The contractor must comply with Proposition 65 requirements.

9.6.3(b) Sealants applied indoors must be non-toxic.

9.6.4 Solvent release sealants include acrylic, butyl rubber, and chlorosulfonated polyethylene and must conform to ASTM C1311.

9.6.5 Latex sealants include latex, acrylic latex, and siliconized acrylic and must conform to ASTM C834.

9.6.6 Elastomeric joint sealants include polysulfide, polyurethane, and silicone and must conform to ASTM C920 or other ASTM standards for elastomeric sealants (e.g., C603, C734, C1250, and D2202).

9.6.7 Foam sealants must be:

9.6.7(a) Minimally expanding

9.6.7(b) Class A or Class 1 per ASTM E84

9.6.7(c) Fire-resistant foam compliant with ASTM E814 or Underwriters Laboratories (UL) 1479

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

35. Shade Screens

Table of Contents

Shade Screens

1. MEASURE OBJECTIVES

1.1 Shade screens minimize solar heat gain from windows exposed to the sun.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 The window meets orientation requirements

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The window opens outward

3.2 Existing shade screens are installed and operable

3.3 The window orientation is between 315º (-45º) and 45º of true north (Fig. 35-1)

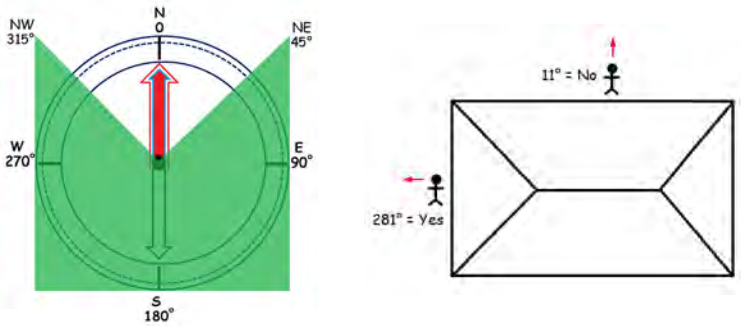


FIG. 35-1: SHADE SCREENS ARE ALLOWED ONLY ON WINDOWS FACING COMPASS READINGS WITHIN THE DARKENED AREA

3.4 The window is in a sleeping room and egress requirements cannot be met

3.5 The window is in shade (e.g., from tree shade, an overhang, or side fins) more than 50% of the time in summer

3.6 Installation would violate the Appendix E Health and Safety Requirements

3.7 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Egress requirements must be retained for sleeping room windows in accordance with Section 1 General Installation Guidelines, Window Egress (Conventional Homes).

4.1.2 The entire window frame must be covered by the shade screen, not just the operable window area.

4.1.3 Replacement of exterior screen material in existing frames with shade screen fabric is acceptable when:

4.1.3(a) The existing screen serves the entire window and

4.1.3(b) The existing frame meets Material Specifications and is not bent or damaged

4.1.4 Patching of an existing screen will not be allowed.

4.1.5 The existing interior insect screen frame shall not be used as a shade screen (Fig. 35-2).

4.1.6 The existing window frame, sashes, and panes must be structurally sound.

4.1.7 Shade screens will be mounted on the exterior only.

4.1.8 Bowing and warping of the screen frame are not allowed.

4.1.9 Windows over 7' wide will be covered with screening constructed of two or more panels.

4.1.10 Tension-mounted shade screens are not allowed.

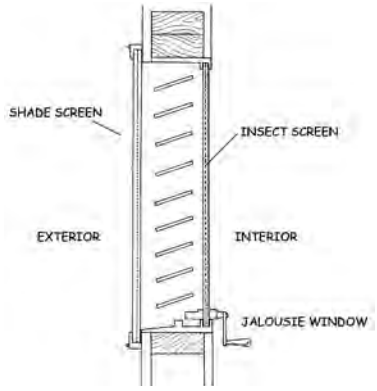


FIG. 35-2: AN EXISTING INSECT SCREEN MAY NOT BE USED AS A SHADE SCREEN

4.2. Installation Procedure

4.2.1 Determine the window orientation per Section 1 General Installation Guidelines, Window Orientation.

4.2.2 Window Frame Preparation

4.2.2(a) Water penetration points will be sealed.

4.2.2(b) Limited dry rot damage to the window frame must be repaired before the shade screen installation in accordance with Section 1 General Installation Guidelines, Limited Home Repair.

4.2.3 Screen Frame Corners

4.2.3(a) Securely join frame corners.

4.2.3(b) Corners on rectangular frames will be square. (Fig. 35-3)

4.2.3(c) Angled corners (rake windows)

4.2.3(c1) Adjust angled corners to match the window frame before the screen fabric is installed and the unit is secured to the window.

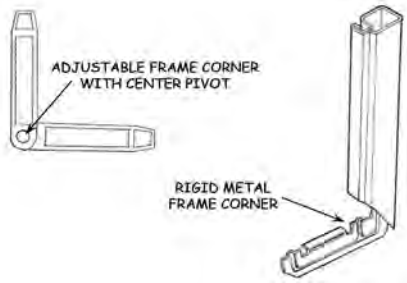


FIG. 35-3: ADJUSTABLE OR RIGID ANGLED CORNERS

4.2.4 Bracing

4.2.4(a) Bracing is required in windows larger than 25 sq. ft.

4.2.4(b) Align the bracing with the meeting rails and grids, when present. (Fig. 35-4)

4.2.5 Screen Fabric Attachment

4.2.5(a) Fasten the screen fabric to the frame in a manner that permits replacement of the screen and the spline.

4.2.5(b) If heavier lines are present in the fabric, they will be positioned vertically.

4.2.6 Frame Attachment

4.2.6(a) Provide a minimum of ½" of space between the shade screen and the glass.

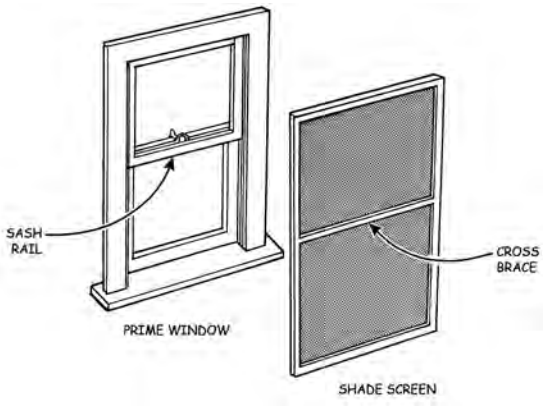


FIG. 35-4: BRACING

4.2.6(b) Use a minimum of four fasteners per screen (Fig. 35-5):

4.2.6(b1) Within 4" of each corner on each vertical side

4.2.6(b2) Spaced at intervals of no more than 2'

4.2.6(c) Fasteners will be compatible with the screen frame and the existing window hardware.

4.2.6(d) Use corrosion-resistant metal rotating clips and screws.

4.2.6(d1) Install the rotating clip so that the barrel of the clip rests on the mounting surface.

4.2.6(d2) Use screws for installations on surfaces into which screws can be installed (e.g., wood trim and traditional thick cement stucco).

4.2.6(d3) Do not install screws in:

- Vinyl window frames
- Exterior insulation and finish systems (EIFS) (thin synthetic stucco over foam board)

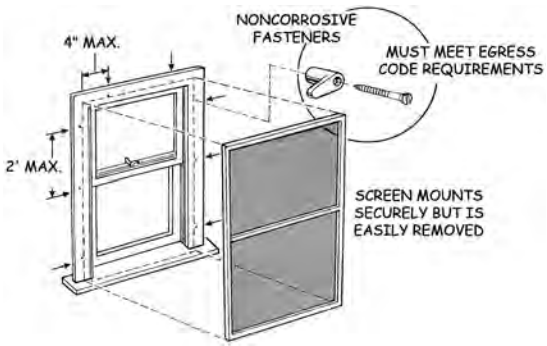


FIG. 35-5: FRAME ATTACHMENT

4.2.6(e) Vinyl windows

4.2.6(e1) Anchors are attached to the window surround (casing or wall), not to the vinyl frame.

4.2.6(e2) U-channel brackets and hook-and-loop (e.g., Velcro®) attached to the window frame are not allowed.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 There are no multi-family whole-building installation requirements. The conventional home (single-family) criteria apply to all multi-family whole-building installations.

6.1.3 When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.3(a) Common area installation (e.g., in a lobby, entertainment room, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Screens will be:

8.1.1(a) Square, plumb, and in alignment with the existing windows

8.1.1(b) Securely mounted but easily removable

8.1.2 Screen fabric will be straight and tight within the frame.

8.1.3 Horizontal bracing will align with meeting rails and grids.

8.2. Client Education

8.2.1 None

8.3. Clean-Up and Disposal Requirements

8.3.1 All scraps and debris from the installation will be removed and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 4 years

9.1.2 DOE: Not applicable to this measure

9.2 Square Corners

9.2.1 Rigid metal internal frame corners will be used.

9.2.2 Adjustable and plastic corners are not allowed.

9.3 Angled Corners (Rake Windows)

9.3.1 Frame corners shall be metal.

9.3.1(a) Adjustable internal frame corners are allowed.

9.3.1(b) Durable, solid plastic (two legs riveted in the center) are acceptable when adjustable metal frame corners are not available.

9.4 Window Screen Frame Materials

9.4.1 Wood is not allowed.

9.4.2 Rigid vinyl is not allowed.

9.4.3 Steel shall be zinc- or cadmium-plated.

9.4.4 Aluminum

9.4.4(a) A minimum of .025" thickness, 7⁄16" x 1" dimension for windows up to 25 sq. ft.

9.4.4(b) A minimum of .032" thickness, 7⁄16" x 1" dimension for windows larger than 25 sq. ft.

9.4.5 Vinyl or fiberglass shall be lead-free and flame-resistant (e.g., National Fire Protection Association [NFPA] 101 Class B CS-191 53, Code of Federal Regulations [CFR] Part 1610.61, International Building Code [IBC] 903.1 Class A).

9.4.6 Metal louvers are not allowed.

9.5 Shading Coefficient

9.5.1 Shade screens must have a shading coefficient of 0.36 or less at a 75º profile angle on clear single-pane glass or be rated to block/absorb/dissipate at least 70% of the sun's heat and glare.

9.6 Clips

9.6.1 Clips must be:

9.6.1(a) Corrosion-resistant metal (not plastic)

9.6.1(b) Compatible with the screen frame

9.6.1(c) Sized so the barrel rests on the mounting surface

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

36. Window Film

Table of Contents

Window Film

1. MEASURE OBJECTIVES

1.1 Window film blocks ultraviolet (UV) rays to help reduce cooling costs in the summer. In winter, window film helps retain heat to reduce heating costs.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 The window orientation is between 45° and 315°

2.2.2 The window is single-paned

2.2.3 It is feasible to install film on the interior surface of the window

2.2.4 Shade screen installation is not feasible or practical

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The existing tinted window film is installed and functional

3.2 The existing window is dual-pane or jalousie

3.3 The window orientation is between 315º (-45º) and 45º of true north (Fig. 36-1).

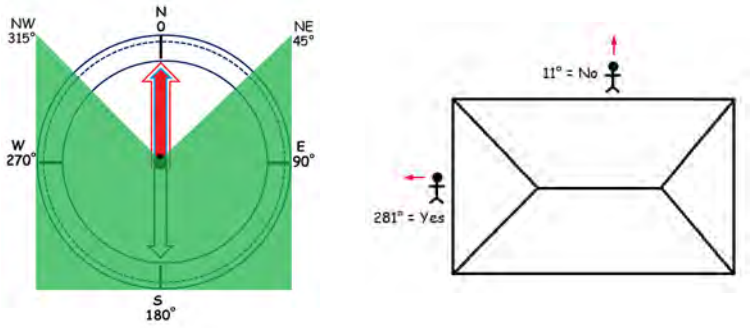


FIG. 36-1: SHADE SCREENS ARE ALLOWED ONLY ON WINDOWS FACING COMPASS READINGS WITHIN THE DARKENED AREA

3.4 The window is in shade more than 50% of the time in summer (e.g., from tree shade, an overhang, or side fins).

3.5 The window or glass is damaged and cannot be repaired. Refer to Section 32 Infiltration Reduction

3.6 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 The existing panes, sashes, and frame shall be structurally sound.

4.1.2 The glass surface shall be free of cracks, holes, and blemishes.

4.2. Installation Procedure

4.2.1 Determine the window orientation per Section 1 General Installation Guidelines, Window Orientation.

4.2.2 Window Film Application

4.2.2(a) Remove all paint spots, adhesive residue, etc. from the window

4.2.2(b) Thoroughly clean the glass to remove all grease and dirt using a manufacturer-approved cleaner.

4.2.2(c) Install the film only on the interior surface of single-pane windows.

4.2.2(c1) The distance between the window frame and the film shall be ≤⅛".

4.2.2(c2) The film must not touch the window frame or sash material (e.g., wood, metal, plastic mullions).

4.2.2(d) Apply a single sheet of film to all windows ≤60" in width or height.

4.2.2(e) In windows >60" in width or height, install splices in accordance with the manufacturer's specifications.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.2 There are no multi-family whole-building installation requirements. The conventional home (single-family) criteria apply to all multi-family whole-building installations.

6.1.3 When the measure will be included in a multi-family whole-building project, the installation will apply only within the dwelling units.

6.1.3(a) Common area installation (e.g., in a lobby, entertainment room, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 The installed film shall have a uniform appearance, without streaks, wrinkles, pinholes, spots, or discoloration.

8.2. Client Education

8.2.1 The client shall be instructed that:

8.2.1(a) A hazy or foggy look to the window immediately following installation of the film is normal and should disappear within a few days

8.2.1(b) The film should be cleaned with mild soap and water or an ammonia-free cleaner using a soft cloth or paper towel

8.3. Clean-Up and Disposal Requirements

8.3.1 All packaging and film remnants will be removed and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 4 years

9.1.2 DOE: Not applicable to this measure

9.2 All Types

9.2.1 Film shall:

9.2.1(a) Be selected to reduce heat and light energy transmission through windows

9.2.1(b) Have a solar heat gain coefficient of 0.35

9.2.1(c) Have a U-factor of 0.40

9.2.1(d) Be UV-treated

9.2.1(e) Be self-adhesive

9.2.1(e1) Non-adhesive film is not allowed.

9.3 Polyester

9.3.1 Minimum thickness: 0.0010" (1 mil)

10. WARRANTY

10.1 Manufacturer—10 years

10.2 Contractor—1 year

37. Attic and Ceiling Insulation

Table of Contents

Attic and Ceiling Insulation

1. MEASURE OBJECTIVES

1.1 Attic/ceiling and knee wall insulation slows the transfer of heat through the thermal boundary, reducing the amount of heat entering the home on a warm day and the amount of heat loss on a cold day.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 The attic/ceiling or knee wall separates conditioned and unconditioned space and

2.2.2 At least 100 sq. ft. of attic or knee wall is feasible to insulate per Table 37-1 or

2.2.2 (a) If the attic access is uninsulated but the remaining attic/ceiling has adequate insulation, the cover shall be insulated as a Limited Home Repair - ECM Support item. See Section 1 General Installation Guidelines, Limited Home Repair Policy.

2.2.2 (a1) Exception: When insulation is unfeasible due to a safety condition in the attic (e.g., presumed asbestos, knob-and-tube wiring, etc.), insulation shall not be added to the access cover.

2.2.3 Insulation has a savings-to-investment ratio (SIR) ≥1.0 as proven by an energy audit

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The existing insulation R-value is measured to be adequate

3.2 One or more of the following conditions are present and have not been (or cannot be) corrected:

3.2.1 Structural defects exist, such as:

3.2.1 (a) 2" x 4" joists measure >24" on center (OC)

3.2.1 (b) Bowed and sagging joists are present

3.2.1 (c) Fiberboard or ¼" gypsum ceiling material is present

3.2.1 (d) Roof leaks that cannot be repaired per Section 1 General Installation Guidelines, Limited Home Repair Policy

3.2.2 An exhaust system terminates in the attic and cannot be vented to the outdoors

3.2.2 (a) For bathroom and laundry venting (including a gas or electric clothes dryer), see Section 1 General Installation Guidelines, Limited Home Repair Policy.

3.2.2 (b) For kitchen exhaust, see Section 11 Kitchen Exhaust.

3.2.3 Existing insulation has been damaged by moisture and is not dry, and the source of the moisture has not been corrected

3.2.4 A combustion appliance safety (CAS) hazard or CAS fail exists, per Appendix A Combustion Appliance Safety Protocol

3.2.5 Electrical hazards exist that cannot be corrected

3.2.6 Hazardous materials are present

3.2.7 There is inadequate attic venting and it cannot be corrected per Section 40 Attic Ventilation

3.2.8 Knob-and-tube (K&T) wiring is present and has not been certified safe for encapsulation or permanently disconnected by a licensed C-10 electrical contractor, per the Section 1 General Installation Guidelines, Knob-and-Tube (K&T) Wiring Guidelines.

3.3 Installation would violate the Appendix E Health and Safety Requirements

3.4 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Attic ventilation may be installed in conjunction with attic/ceiling insulation, or as a stand-alone measure per Section 40 Attic Ventilation.

4.1.2 This measure is a whole-building measure. In single-family dwellings (1-4 units) and multi-family buildings (with 5+ units), the whole building must be is served for attic and ceiling insulation to be installed. See Appendix D Energy Audit/Priority List Protocol.

4.1.2 (a) Under the Low Income Home Energy Assistance Program (LIHEAP), when an energy audit will not be conducted, attic/ceiling insulation may be installed for an individual unit in a duplex, tri-plex, or four-plex only when there are no shared attic spaces between dwelling units (i.e. the attic spaces are separated by a complete and continuous pressure boundary or firewall, and the units have separate heating and/or cooling units).

4.1.3 Title 24 and Permit Requirements

4.1.3 (a) When required by the local jurisdiction, a permit is required when ceiling insulation is installed because the ceiling is considered "altered" (2022 Title 24).

4.1.4 Audited Measures

4.1.4 (a) When this measure will be installed under the Low Income Home Energy Assistance Program (LIHEAP) and an energy audit is performed, if the measure will be fully leveraged or co-funded, it must comply with Appendix D Energy Audit/Priority List Protocol.

4.1.4 (b) When this measure is paid for by LIHEAP, or is co-funded with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply.

4.1.5 If existing insulation is a potential fire hazard due to insulation covering heat-producing devices (HPDs) or combustion ventilation air (CVA) vents, these fire hazards shall be corrected by field personnel. See Section 1 General Installation Guidelines, Fire hazards and venting obstructions.

4.1.6 All air leakage locations (including duct and shell leaks, and thermal bypasses in the ceiling) shall be sealed prior to installation of insulation per Section 32 Infiltration Reduction and Section 8 Ducting Repair, Sealing and Insulation.

4.1.7 All repairs or installations requiring attic access shall be completed before insulation is installed.

4.1.8 Attic must be accessible in accordance with the clearance requirements for attics identified in Section 1 General Installation Guidelines, Attic and Crawlspace Accessibility.

4.1.9 K&T Wiring

4.1.9 (a) If a C-10 electrician certifies the K&T wiring is safe for encapsulation, insulation may be installed per Section 1 General Installation Guidelines, Knob-and-Tube (K&T) Wiring Guidelines.

4.1.10 Knee Wall Insulation

4.1.10 (a) Uninsulated knee walls may be insulated even when ceiling insulation is not installed.

4.1.11 Adding New Insulation

4.1.11 (a) Existing insulation shall be in contact with the air barrier prior to the installation of additional insulation.

4.1.11 (b) New insulation installed over existing insulation (new + existing) shall bring the level up to the final R-value shown in Table 37-1.

4.1.11 (c) Ceiling insulation must be installed on the attic floor to a level of R-49, except when:

4.1.11 (c1) New insulation would disturb ACM or PACM located in the ceiling, attic, or ductwork

4.1.11 (c2) Knob-and-tube wiring is in the attic

4.1.11 (c3) The installation of insulation would be in a shared attic (multi-unit) where other dwelling units (attic spaces) do not receive insulation.

4.1.11 (d) A minimum of 1" air gap must be kept between the insulation and roof deck, as well as at all vent locations.

4.1.11 (d1) The use of blocking and installation of insulation must not block the free flow of air.

4.1.11 (d2) If the attic height prevents installing to the required insulation level (per Table 37-1), as much insulation as possible must be added while still maintaining roof clearance and attic ventilation requirements.

4.1.11 (e) When insulating to R-49, permanent blocking materials/dams shall be mechanically attached to prevent overblow of insulation where clearances must be maintained.

4.1.11 (f) If using loose fill insulation, baffles shall be installed at eaves or soffit vents to prevent insulation from blocking ventilation and to prevent air movement under the insulation.

TABLE 37-1: INSULATION INSTALLATION CRITERIA

Existing Insulation R-Value	CEC Climate Zone[1]	Required Action
Ceiling and Horizontal Access Cover Insulation		
Less than R-19	1, 3	Verify/install attic ventilation. Confirm IC fixtures or cover non-IC fixtures. Increase insulation to R-49. Not required: Sealing of the attic floor
	2, 4, 8 – 16	Verify/install attic ventilation. Seal the attic floor. Confirm IC fixtures or cover non-IC fixtures. Increase insulation to R-49.
	5, 7	Verify/install attic ventilation. Increase insulation to R-49[2]. If required by local jurisdiction: • Sealing of the attic floor • IC fixture replacements/non-IC cover retrofits
	6	Verify/install attic ventilation. Increase insulation to R-49. Not required: • Sealing of the attic floor • IC fixture replacements/non-IC cover retrofits

TABLE 37-1: INSULATION INSTALLATION CRITERIA

Existing Insulation R-Value	CEC Climate Zone[1]	Required Action
Between R-19 and R-38	1, 3, 5 – 7	Verify/install attic ventilation. Increase insulation to R-49[2]. If required by local jurisdiction: • Sealing of the attic floor • IC fixture replacements/non-IC cover retrofits
	2, 4, 8 – 10	Verify/install attic ventilation. Increase insulation to R-49.
	11 – 16	Verify/install attic ventilation. Confirm IC fixtures or cover non-IC fixtures. Increase insulation to R-49.
Knee Wall, Skylight Well, and Vertical Access Cover Insulation		
None existing	2x4" framing	Increase to R-13
None existing	2x6" framing	Increase to R-19
[1]As defined by the California Energy Commission [2]Not required by Title 24, but required by Program		

4.1.12 R-Value Defaults for Existing Insulation

4.1.12(a) When there are multiple layers of different insulation types, the R-value of each layer is evaluated separately (Table 37-2).

4.1.12(b) The sum of the R-values equals the overall existing R-value for the attic.

4.1.12(c) Compression by the weight of added new insulation shall be factored in when estimating the effective R-value of existing insulation.

4.1.12(d) When the existing insulation level in an attic is uneven (more than one level is present), an “average existing R-value” shall be determined and documented.

4.1.12(d1) The “average existing R-value” is defined as the lowest R-value presently installed in more than 50% of the attic.

TABLE 37-2: INSULATION R-VALUE DEFAULTS

Insulation Type and Material	Insulation R-Value per Inch
Loose Fill	
Cellulose	3.7
Fiberglass—Virgin (White)	2.8
Fiberglass—Pink & Yellow	2.8
Rock Wool	3.0
Perlite	2.7
Redwood Bark	1.0
Unidentifiable Material	1.0
Batts and Blankets	
Fiberglass	3.0
Rock Wool	3.0

4.1.13 R-Value of Existing Flexible Insulation (Batts)

4.1.13(a) Properly installed batts in excellent condition are assumed to have the R-value marked on the facing. If the insulation is not compressed but there are no markings on the facing, use the following defaults:

4.1.13(a1) 3½" = R-11

4.1.13(a2) 6" = R-19

4.1.13(a3) 10" = R-30

4.1.13(b) If batts are compressed or damaged:

4.1.13(b1) Measure the average thickness and

4.1.13(b2) Use the R-value per inch in Table 37-2

4.1.14 Attic Ventilation Verification Requirements

4.1.14(a) When any work occurs in an existing attic, minimum ventilation must be met, with no exception. Refer to Section 40 Attic Ventilation.

4.1.14(b) The net free venting area (NFVA) must be a minimum 1/150 of the attic space area.

4.1.14(c) Vent mesh shall be no smaller than 1/16"and no greater than ¼".

4.1.15 Recessed ("Can") Lighting Requirements

4.1.15(a) When required by Table 37-1, recessed/can lighting fixtures in the ceiling must be covered with insulation to the same depth as the attic floor.

4.1.15(a1) Any standard recessed lighting fixtures must be:

- Replaced with an air-tight IC-rated fixture (IC = Insulation Contact), or
- The existing fixture must be made safe for, and retrofitted with, a listed fireproof cover or box.

4.1.15(b) For a cover to be installed on a non-IC rated fixture, the fixture must have a "thermal switch" to disconnect the electricity to the light if the temperature exceeds safe levels. If the thermal switch is not present, the non-IC-rated fixture shall be replaced.

4.1.15(c) If it cannot be determined whether a fixture is IC-rated or not, it should be assumed that it is not.

4.1.15(d) Existing IC-rated fixtures do not need to be airtight. Installed IC-rated fixtures must be sealed with a gasket or caulking between the light fixture housing and the ceiling.

4.1.15(e) When this work is required as a condition of permit for ceiling insulation, the materials and labor shall be attributed to the Limited Home Repair-H&S Support measure.

4.1.16 Sealing of the Attic Floor Requirements

4.1.16(a) Prior to the installation of ceiling insulation, all accessible areas of the attic floor between the attic and the conditioned space must be air sealed, except when:

4.1.16(a1) Table 37-1 indicates that it is not required.

4.1.16(a2) The dwelling has open combustion space heating or water heating appliances located inside the building pressure boundary. This exception does not apply when the open combustion appliance is in a vented attic, garage, or crawlspace.

4.1.16(a3) The existing insulation is vermiculite (unless the existing insulation does not contain asbestos as tested by a certified laboratory).

4.1.17 Blocking Requirements

4.1.17(a) Blocking shall be used to:

4.1.17(a1) Prevent new and existing loose-fill insulation from contacting HPDs, appliances, etc. (Fig. 37-1)

4.1.17(a2) Prevent insulation from obstructing vents required for combustion ventilation air and attic ventilation.

4.1.17(a3) Keep loose-fill insulation surrounding the attic access in place.

4.1.17(b) Blocking is not required when loose fill is not present.

4.1.17(c) Permanent blocking shall extend from the attic floor and exceed the height of the loose fill by 4" or to the prescribed height using structural wood or a combination of structural wood and other approved material.

4.1.17(d) When batt insulation is installed over loose fill, the blocking/barrier shall prevent the existing loose fill from entering the clearance zone (Fig. 37-1).

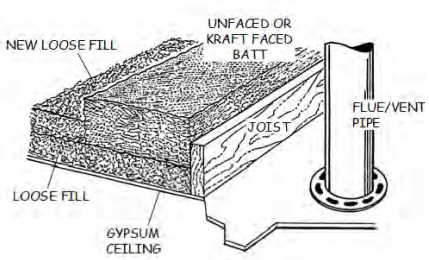


FIG. 37-1: AN EXAMPLE OF BLOCKING

4.1.17(e) Batt blocking using unfaced and faced batts:

4.1.17(e1) Shall extend from the clearance zone at least an additional 14½" in all directions

4.1.17(e2) Temporary blocking may be used to shield an HPD clearance zone or vent for accidental "overblow" of loose fill but must be removed following insulation installation.

4.1.17(f) After loose-fill insulation has been installed, the clearance zone shall be free of overblown insulation and other material.

4.1.17(g) HPD blocking

4.1.17(g1) Permanent blocking materials are as noted in the section for each HPD:

- Faced or unfaced batts when allowed
- Corrosion-resistant metal attached to structural framing members when allowed
- Plastic chutes, cardboard baffles, or metal for eave vent chutes and baffle shall not be used to block HPDs.

4.1.17(g2) HPD clearance zones shall be a minimum of 3" or as specified for the item in the following sections, but no greater than necessary to provide proper blocking.

4.1.17(g3) Blocking is not required if an HPD is mounted above the top of the insulation.

4.1.17(g4) When an HPD is covered by a fire-rated, airtight enclosure, insulation must not cover the top of the enclosure.

- The enclosure material shall:
  - The entire closure will maintain a 3" clearance between the closure and the fixture including wiring, box, and ballast
  - Have a 24" minimum clearance above the HPD
  - Be fire-rated with an R-value of 0.50 or less when airtight
  - Caulk, mastic, or foam will be used on all edges, gaps, cracks, holes, and penetrations of the closure material.
  - Note: Gypsum enclosures that house fluorescent or light-emitting diode (LED) light fixtures do not require protection from loose-fill insulation.

4.1.17(h) Restricted access to eave/soffit vent with HPD present

4.1.17(h1) When the HPD is ≤18" from an eave/soffit vent and the clearance between the ceiling joists and rafters is ≤14" at the edge of the clearance zone (Fig. 37-2):

- The clearance zone shall be free of loose fill
- A minimum 3" clearance is required between the HPD and the blocking material

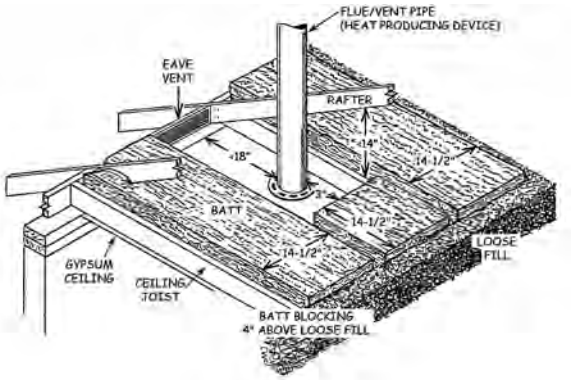


FIG. 37-2: RESTRICTED ACCESS TO EAVE/SOFFIT VENT WITH HPD PRESENT

- Between joists adjacent to the HPD, batt blocking shall be installed that rests on the attic floor, extends inward at least 14½", and/or exceeds the height of the installed loose fill by 4"
- Along the outside of each joist adjacent to the HPD, batt blocking shall be installed (may rest on existing loose fill) that extends away from the clearance zone at least 14½" and/or exceeds the height of the installed loose fill by 4".

4.1.17(i) Gas and solid fuel vent pipes and masonry chimneys

4.1.17(i1) Gas and solid fuel vent pipes and masonry chimneys shall be blocked.

4.1.17(i2) Unused (e.g., abandoned) vent pipes shall be blocked.

4.1.17(j) Kitchen and bath exhaust vents

4.1.17(j1) If an exhaust fan is an HPD, it shall be blocked.

4.1.17(j2) A vent duct may be covered by loose-fill insulation when the fan is below the ceiling.

4.1.17(k) Attic open to uninsulated soffits

4.1.17(k1) Attic open to uninsulated soffits containing recessed light fixtures may be insulated if loose fill is kept away from the HPDs and off the soffit by one of the following methods:

- Top-fill method (Fig. 37-3)—Cavities are:
  - Filled from the top with loose-fill up to the soffit and
  - Insulated the remaining distance to the top plate with flexible or rigid material
- Top-seal method—Cavities are:
  - Securely sealed at the soffit/ ceiling level and
  - Pressure-filled from below and
  - Insulated the remaining distance to the top plate with flexible or rigid material

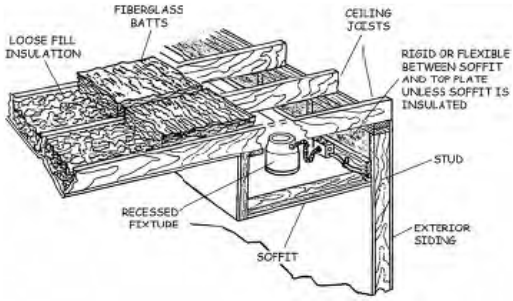


Fig. 37-3: Top-Fill Insulation Method

4.1.17(l) Appliances located in attics

4.1.17(l1) Insulation overblow shall be cleared from the unit, clearance zone, and platform.

4.1.17(l2) Platforms and catwalks

- Insulation shall be installed underneath both.
- Insulation shall not be installed on top of platforms.

4.1.17(l3) Whole house fans

- Blocking is required even when a shroud is present on the fan. (Fig. 37-4)
- A 3" clearance zone is required for the fan motor.
- The sides of the fan insulation box (shroud) assembly will be insulated to the same R-value as the adjoining insulated assembly.
- The fan insulation box frame shall be continuously weatherstripped to ensure a tight fit.
- The fan insulation box will be constructed at a depth to protect the fan housing and motor from insulation.

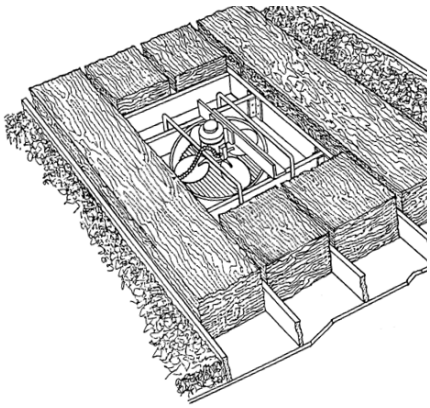


Fig. 37-4: Whole House Fan Insulation Box (Shroud)

4.1.17(l4) Furnaces and heat pumps

- Loose fill:
  - 12" clearance around the back, sides, and top
  - 24" of clearance in front
  - 3" clearance for vent pipes
  - Blocking of the platform is required unless the bottom of the unit is more than 4" above the loose fill.
  - If a heating, ventilation, and air conditioning (HVAC) unit is suspended or draws combustion air from the bottom:
    - A 12" clearance shall be provided below the unit or
    - Batts shall be installed minimum 6" below that extend 12" beyond the unit on all sides (no exposed loose fill beneath the unit)
- Batt insulation:
  - 12" clearance required on all sides
  - 3" clearance for vent pipes
  - 6" clearance below units drawing combustion air from bottom

4.1.17(l5) Electric water heater

- A 3" clearance from the unit is required on all sides.
- Blocking is required if the bottom of the unit touches the installed loose fill.

4.1.17(l6) Gas water heater

- 6" clearance around sides and back
- 12" clearance in front
- 3" clearance for vent pipes

4.1.17(l7) Blocking is required if the bottom of the unit is ≤4" above the installed loose fill.

4.1.17(m) Electrical wiring hazards:

4.1.17(m1) Visible open junction boxes:

- Install a standard cover plate or a minimum 14½" piece of unfaced batt that covers the box and equals or exceeds the height of installed loose fill.
- When a cover plate has been installed, it is acceptable to blow loose-fill insulation over a covered junction box.

4.1.17(m2) Visible wire connections without a junction box require a junction box and cover to be installed.

4.1.17(n) Combustion air vent blocking

4.1.17(n1) Closet openings/ceiling vents to the attic which are not used for CVA are catastrophic leaks and shall be sealed.

4.1.17(o) Attic access blocking

4.1.17(o1) Each functional/usable access and disappearing stairs assembly shall be permanently blocked with a durable, rigid, protective baffle that is higher than the level of the surrounding attic floor insulation to achieve uniform R-value on the attic floor and prevent loose attic floor insulation from entering the living area.

4.1.17(o2) Metal blocking material shall not be installed.

4.1.17(o3) Where wood extends from the attic floor to the top of the installed loose fill, additional blocking is not required.

4.1.17(o4) Where wood extends from the attic floor but does not equal the height of the installed loose fill, blocking shall be added.

4.1.17(o5) Batts are acceptable to use in combination with wood members to achieve the required height.

- Where wood is not present, batt blocking shall rest on the attic floor and extend to the top of the loose fill.

- Batts shall extend at least 14½" away from the access opening in all directions.

4.1.17(p) Eave and soffit vent blocking

4.1.17(p1) Applies to individual and continuous vents.

4.1.17(p2) Blocking (batt, chute, baffle, etc.) shall be installed and extend to the top plate.

- Installation will allow for the highest possible R-value above the top plate of the exterior wall.
- Minimum 2½" clearance is required between the roof sheathing and the blocking.
- Vent screens shall be free of loose fill.

4.1.17(p3) Horizontal batt blocking shall rest on existing loose fill, provided no loose fill is exposed at the top plate.

- Blocking that extends inward 14½" shall exceed the height of the loose fill by 4".
- Blocking that extends inward 24" shall equal or exceed the height of the loose fill.

4.1.17(p4) Restricted access to eave or soffit vent

- Batt blocking shall be installed with a minimum 2½" air path/clearance between:
  - The vent and the blocking
  - The blocking and the roof sheathing
  - The insulation and the roof sheathing
- Blocking shall exceed the height of the loose fill or extend inward at least 24".
- Blocking shall be placed over existing loose fill if an unfaced batt is used and loose fill is not blocking the vent.

4.1.17(p5) Baffles and chutes attached to rafters:

- Shall rest on (begin at) the top plate and extend above the loose fill a minimum of 4" and a maximum of 12"
- Shall be permanently attached with a minimum of two mechanical fasteners per rafter
- Shall be kept 3" away from HPDs
- May be composed of pre-formed plastic, pre-cut cardboard, metal, plywood, or gypsum in accordance with the material specifications
- Shall prevent loose fill from entering at the bottom and edges

4.1.17(p6) Pre-formed ventilation chutes

- Molded plastic shall provide a minimum air path of:
  - 2" x 12" for rafters 16" OC
  - 2" x 18" for rafters 24" OC
- Restricted access to ventilation chute
  - Batt blocking shall be installed with minimum 2½" clearance/air path between:
    - The blocking and the roof sheathing and
    - The vent and the blocking

4.1.17(q) Balloon framing blocking

4.1.17(q1) Blocking shall prevent loose fill from falling down into open wall cavities and into the crawlspace or basement

4.2. Installation Procedure

4.2.1 Protection of Dwelling and Contents

4.2.1(a) When attic access is indoors, protect the pathway from the entrance door to the attic access with runners.

4.2.1(b) Before entry is made into the attic from the living space, place a drop cloth under the attic access.

4.2.1(c) When entry is through an access inside a closet, remove or cover the clothing and other personal property in the closet.

4.2.1(d) Prevent damage to the home and furnishings from the insulation hose, ladders, etc.

4.2.1(e) Cut batts outside the living space or inside the attic.

4.2.1(f) When carrying batts, enclose batts in plastic or other method to prevent releasing fibers in the living area.

4.2.1(g) When accessing a flat-roofed attic from the interior, mask the interior for dust control during drilling.

4.2.2 Equipment Preparation

4.2.2(a) When using the client's electricity, confirm the electrical supply will support the blowing machine power demand.

4.2.2(b) Perform the blowing machine pressure test with air on full, feed off, agitator running, and gate closed.

4.2.2(c) Hose outlet pressure will be at least 80 inches of water column (IWC) or 2.9 lbs. per sq. in. (psi) for cellulose insulation; for other types of insulation, check manufacturer specifications for blowing machine set-up.

4.2.3 Attic Preparation

4.2.3(a) Seal all feasible leakage locations (including duct and shell leaks and thermal bypasses in the ceiling) before insulation is installed, per Section 32 Infiltration Reduction and Section 8 Ducting Repair, Sealing and Insulation.

4.2.3(b) Install loose-fill insulation blocking for HPD and vent clearance zones and ceiling access following the requirements in Blocking Requirements.

4.2.3(c) Verify that blocking, hazard mitigation, ventilation, sealing of air leakage/thermal bypasses, exhaust vent termination, ceiling access, and all other measure requirements have been met before installing insulation.

4.2.3(d) Probe each cavity, locating all attic floor joists and blockers.

4.2.3(e) Install one insulation depth marker for every 300 sq. ft. of attic area, with the bottom of the marker at the air barrier to determine where additional insulation is needed.

4.2.3(e1) Leave the markers in place after insulation is installed for verification by the inspector.

4.2.3(f) When existing batts are incorrectly installed with vapor barrier on top (facing upward):

4.2.3(f1) Remove the vapor barrier from the attic or

4.2.3(f2) Turn the batts over to place the facing against the attic floor or

4.2.3(f3) Slash the vapor barrier the entire length of the batt or across the width of the batt at 12" intervals (Fig. 37-5).

4.2.3(f4) Adjust the existing batt insulation to be in full contact with the attic floor and the rafters with no voids.

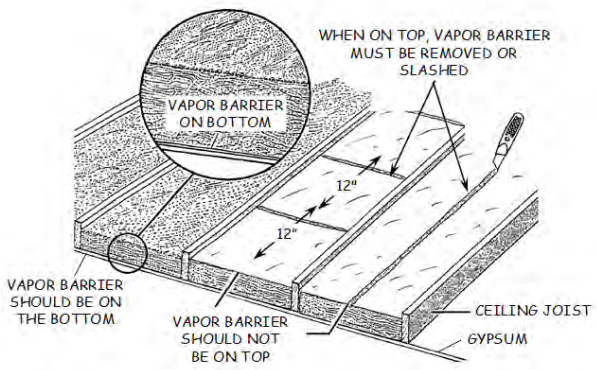


FIG. 37-5: INSTALL VAPOR BARRIER TOWARD WINTER WARM SIDE AND CORRECT IMPROPER INSTALLATION

4.2.4 Installation of Insulation

4.2.4(a) All insulation shall be installed in accordance with the manufacturer's specifications and local code without gaps, voids, compressions, or misalignments.

4.2.4(b) Batt insulation

4.2.4(b1) New unfaced batts shall be placed over existing loose fill or batts to achieve the desired R-value.

- If the top of the existing insulation is below the top of the framing, install new batts parallel with the framing members.
- If the top of the existing insulation is above the top of the framing, install new batts perpendicular to the framing members.

4.2.4(b2) Vapor barrier

- When required by the local jurisdiction, vapor barrier criteria apply to batts installed directly onto the attic floor, knee wall, or skylight well.
- Vapor barrier shall not be installed over existing insulation. When insulation is installed, vapor barrier shall be placed toward the winter warm side (e.g., directly on the attic floor) (Fig. 37-5).

4.2.4(c) Loose-fill insulation

4.2.4(c1) New loose-fill insulation shall be installed over existing loose fill or batts to achieve the desired R-value.

4.2.4(c2) Avoid blowing insulation into clearance zones for HPDs, K&T wiring, vents, etc.

4.2.4(c3) Blown insulation shall be level and even, with no drifts.

4.2.4(c4) After insulation has been installed, clear overblown insulation from vents and clearance zones around HPDs and appliances.

4.2.4(d) Dense pack insulation

4.2.4(d1) Follow the manufacturer's requirements for the dense pack application.

4.2.4(d2) Cavities shall be free of hazards, intact, and able to support dense pack pressures.

4.2.4(d3) Ensure all existing batts are in full contact with interior cladding and top and bottom plates.

4.2.4(d4) Air barrier material shall not bend, sag, or move once dense packed.

4.2.4(d5) Knee wall, partial sloped ceilings, and enclosed cavities

- The existence of air barrier material in line with knee walls shall be verified or installed when dense packing.
- Backing support
  - Verify all knee walls have a top and bottom plate or blockers installed with rigid material.
  - Seal all gaps, holes, and leaks at the floor joist running under the knee wall.
  - When fabric is used, secure the fabric with 1" crown staples every 2" or with furring strips on every wall stud.
  - When rigid material is used, install material to cover the entire accessible surface.
  - When foam sheathing is used, it shall be listed for uncovered use in an attic or covered use with a fire barrier.
- Unvented flat roofs
  - When accessing the cavity from the interior, locate drilling hazards (e.g., wiring, venting, fuel piping) prior to drilling.

4.2.4(e) Attic access insulation

4.2.4(e1) All ceiling entry doors/covers accessed from conditioned space, even if not functional/usable, shall be insulated in accordance with Table 37-1.

4.2.4(e2) Flexible or rigid insulation, with an R-value equal to attic floor, shall be permanently attached to the cover.

4.2.4(e3) Disappearing stairs

- When accessed from conditioned space:
  - A hinged lid shall be installed if not already present
  - Non-compressible insulation with R-value equivalent to the attic floor insulation shall be permanently attached to the lid and include a protective barrier or baffle
- Stairs with a bottom door (or lid if there is no bottom door) or stairs with a top lid:
  - The entire pull-down stair assembly will be covered with an airtight and removable/openable enclosure inside the attic space.

4.2.4(f) Knee walls and skylights

4.2.4(f1) Existing batts shall be in full contact with interior cladding and top and bottom plates.

4.2.4(f2) Uninsulated knee wall areas over 12" in height (after attic floor insulation is installed) and uninsulated skylight wells shall be insulated to the R-value in Table 37-1.

4.2.4(f3) Installed insulation shall be in full contact with all sides of the knee wall cavity.

- All knee walls will have a top and bottom plate or blockers installed using a rigid material.
- All joints, cracks, and penetrations will be sealed in finished material, including interior surface-to-framing connections.

4.2.4(f4) Knee walls without framing

- A rigid insulated sheathing of the required R-value shall be mechanically fastened.

4.2.4(g) Partial sloped ceiling and knee wall combinations

4.2.4(g1) Batts may be installed in partial sloped ceiling cavities.

- Loose fill is not allowed.

4.2.4(g2) A minimum of 1" of air space is required between the batts and the roof sheathing.

4.2.4(h) Unvented flat roofs

4.2.4(h1) Code-compliant ventilation shall be installed before insulation is installed.

4.2.5 Insulation Certificate

4.2.5(a) An insulation certificate (CSD 610 form) shall be completed and signed by the contractor responsible for installing the insulation.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

5.1.2 Before installing this measure, prior approval must be granted from the California Department of Housing and Community Development (HCD), or another authority having jurisdiction.

5.1.3 Structural Requirements

5.1.3(a) All methods

5.1.3(a1) Trusses shall be capable of withstanding:

- The added weight of the insulation system
- The increased snow load resulting from reduced heat loss through the roof

5.1.3(a2) The ceiling condition shall be such that all holes, cracks, and other bypasses into the roof cavity can be effectively repaired and sealed to minimize permeation of household moisture into the roof cavity.

5.1.3(a3) See (Fig. 37-6)

5.1.3(b) Cavity fill method–specific

5.1.3(b1) The ceiling shall be structurally adequate to support the weight of the added insulation plus the blowing machine pressure without bulging or sagging.

5.1.3(b2) Maximum ceiling panel deflection after cavity fill shall be ¼" in 4' of lateral run.

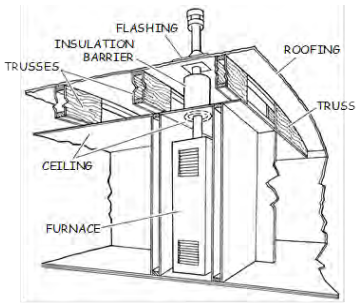


FIG. 37-6: MOBILE HOME ROOF STRUCTURE

5.1.4 Ceiling Soundness

5.1.4(a) Ceiling panel attachments

5.1.4(a1) Additional attachments shall be installed as needed for support and to prevent excessive ceiling sag.

5.1.4(a2) Loose ceiling panels will be secured.

5.1.4(b) Ceiling panel repair

5.1.4(b1) Weak, deteriorated, or broken ceiling panels anywhere in the area to be insulated shall be repaired/replaced as needed to prevent ceiling panel collapse or excessive sag.

5.1.4(b2) Repairs in open, visible areas shall match the existing finish or material as closely as possible.

5.1.5 HPD Blocking

5.1.5(a) Barrier installation access

5.1.5(a1) Access for installation may include the temporary removal of:

- The HPD
- The ceiling trim or trim collar
- A small amount of ceiling material immediately surrounding the HPD
- The roof flashing

5.1.5(b) Post-blocking requirements

5.1.5(b1) HPDs that were removed to facilitate roof cavity insulation installation shall be properly reinstalled.

5.1.5(b2) Gaps created by removing ceiling material shall be filled with the material removed or other appropriate material as needed.

5.1.5(c) Vent pipes

5.1.5(c1) The space between combustion appliance vents and the ceiling that are allowed to be sealed will be sealed with fire-rated materials.

5.1.5(c2) Ceiling collars and other trim material shall be properly reinstalled.

5.1.5(c3) All combustion appliance flues and vents will be terminated to the exterior of the house and terminations will maintain proper clearance above snow loads.

5.1.6 Roof Repair

5.1.6(a) Leaks

5.1.6(a1) All leaks that can allow household moisture to penetrate the walls or ceiling and permeate the roof cavity shall be sealed (Fig. 37-7).

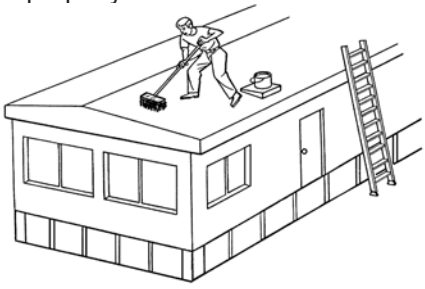


FIG. 37-7: ROOF LEAKS MUST BE REPAIRED BEFORE INSULATION IS INSTALLED

5.1.6(a2) Dishing and pooling issues that allow standing water shall be addressed.

5.1.6(a3) All broken roof cavity vents shall be replaced or removed and sealed.

5.1.6(a4) Leaks in the existing roof shall be sealed prior to installation of a roof cap.

5.1.6(a5) Defective roof-mount flashing devices shall be replaced.

5.1.6(b) Repair methods

5.1.6(b1) All surfaces shall be cleaned, and materials shall be applied as instructed.

5.1.6(b2) All sealants shall be compatible with the existing roof surface.

5.1.7 Insulation Methods

5.1.7(a) Insulation methods shall be selected based on the limitations described below.

5.1.7(b) Roof cap insulation method

5.1.7(b1) Shall be installed only on mobile homes in which:

- The ceiling structure is not capable of supporting, or is too shallow to accept, a minimum R-11 cavity fill
- The dwelling is equipped with a functioning, permanent air conditioner and/or electric forced air heating system

5.1.7(c) Gable end insulation method

5.1.7(c1) Insulate from the gable ends when the truss height is ≥10" at the apex.

5.1.7(c2) Insulation shall be:

- Used to fill the area immediately adjacent to gable ends where proper distribution can be verified by visual inspection
- Performed in conjunction with interior ceiling bore or exterior roof edge cavity fill methods (not used to insulate the entire roof cavity)
- Blown in, leaving a minimum 1" gap below the roof for air circulation
- A minimum R-value of R-11 and a maximum of R-30.

5.1.7(d) Exterior roof edge cavity fill method

5.1.7(d1) Shall be restricted to ceilings and roofs that:

- Can support the weight of added insulation and blowing pressure
- Are covered by metal roofing material
- Do not contain an underlayment of wood sheathing
- Can feasibly be detached and lifted in segments along the edge
- Have sufficient height to allow a minimum R-11 pressure fill

5.1.7(d2) The existing roof shall be free of damage and deterioration that would prevent restoration to a watertight condition following installation.

5.1.7(e) Interior ceiling bore cavity fill method

5.1.7(e1) May be installed in any mobile home with:

- A ceiling structure capable of supporting the added insulation and blowing pressure
- A roof cavity deep enough to accept a minimum R-value of R-11 and a maximum of R-30

5.2. Installation Procedure

5.2.1 Preparation of the Home

5.2.1(a) Avoid damage to the home and furnishings by the insulation hose, ladders, etc.

5.2.1(b) Use special precautions to limit fiberglass and construction dust exposure to the clients and their belongings.

5.2.1(c) When the interior ceiling bore cavity fill method is performed:

5.2.1(c1) Protect all floors, furniture, appliances, clothing, and other personal belongings from dust (e.g., with drop cloths)

5.2.1(c2) Capture drilling dust and debris (e.g., by holding a high-efficiency particulate air [HEPA] filter vacuum intake near the hole being drilled).

5.2.2 Ceiling Preparation

5.2.2(a) Ceiling vents not used for combustion air

5.2.2(a1) Seal the vent openings with minimum ½" gypsum, plywood, or metal and covered with insulation.

5.2.2(a2) Vents shall not be sealed with batts or foam board.

5.2.3 Cavity-Fill Insulation Methods

5.2.3(a) Blower set-up

- Set the hose outlet pressure in accordance with the manufacturer's specifications.
- The blowing machine shall be controlled with a remote switch.
- The fill tube diameter shall be a minimum of 2".

5.2.3(b) Material placement

- Install insulation into the void of the ceiling cavity:
  - If existing insulation is roof-mounted, insulation shall be blown below.
  - If existing insulation is ceiling-mounted, insulation shall be blown above.
  - If existing insulation is mounted at both locations, insulation shall be blown in between.

5.2.3(b1) Avoid overfilling at roof edges and above ceiling trusses.

5.2.3(b2) Installation shall leave a minimum 1" gap below the roof for air circulation.

5.2.3(c) Density of cavity fill

5.2.3(c1) Insulation thickness and density shall be a minimum of R-11 and a maximum of R-30.

5.2.3(c2) Using the fill tube, fill 100% of each cavity to a consistent density.

5.2.3(d) Ceiling performance

5.2.3(d1) Correct any excessive ceiling panel stress caused by insulation weight and pressure.

- Tighten loose attachments.
- Install additional attachments as needed to secure ceiling panels to joists.
- Maximum ceiling panel warpage deflection after cavity fill shall be ¼" in 4' of lateral run.

5.2.3(e) Temporary ceiling bracing is recommended during the installation process.

5.2.4 Roof Cap Method

5.2.4(a) The roof cap method shall consist of minimum R-11 rigid insulating material installed over the existing roof and capped with an overlay of metal roofing or a synthetic membrane

5.2.4(b) Roof cap system design/permitting

5.2.4(b1) System design for roof cap insulation shall be submitted to and approved by HCD prior to any installation activities.

5.2.4(c) Rigid insulation

5.2.4(c1) Rigid foam shall be pre-formed expanded polystyrene or pre-formed polyisocyanurate.

5.2.4(c2) Roof board shall be high-density fiberglass.

5.2.4(c3) Attachment (Fig. 37-8):

- Metal roofing roll-back, cutting, or boring is prohibited.
- Insulating panels shall be secured to the metal roof with screws and washers.

5.2.4(d) Metal roof cap systems

5.2.4(d1) Continuous roll-on roofing with factory-sealed seams:

- Required on a curved roof and recommended on all roofs

5.2.4(d2) Individual panel metal roofing:

- Shall have interlocking standing seams to permanently seal against water penetration (Fig. 37-9)

5.2.4(e) Synthetic membranes

5.2.4(e1) Membranes that are spliced and attached with a permanent vulcanizing process may be installed in continuous strips at least 6' wide and run the length of the roof.

5.2.4(f) Wood edging and furring

5.2.4(f1) Wood edging and furring attachment (Fig. 37-10)

- Utilize screws to attach wood members to the framework of the existing roof.

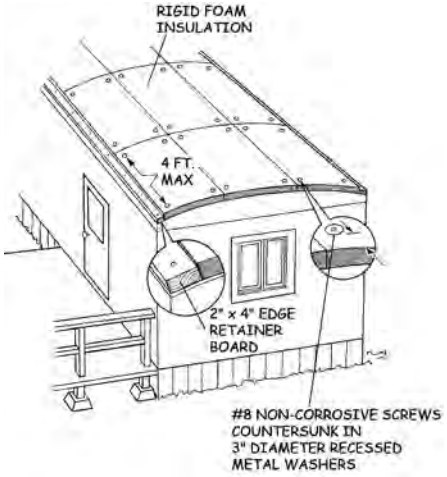


Fig. 37-8: Rigid Insulation Attachment

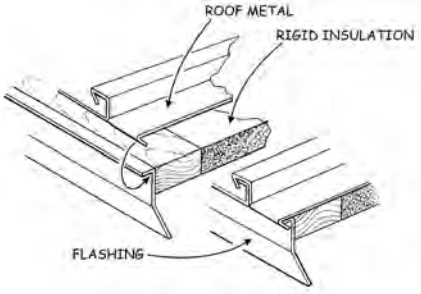


Fig. 37-9: Interlocking Standing Seams on Metal Roof Cap System

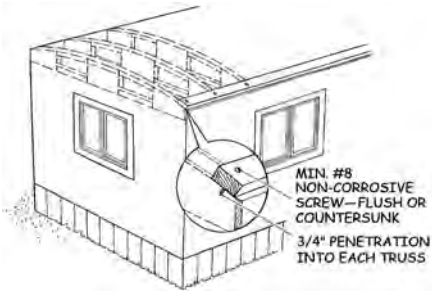


Fig. 37-10: Attachment of Wood Edging and Furring

5.2.4(g) Metal edging, drip rail, ridge cap, and similar components

5.2.4(g1) Securely attach metal components to the mobile home framework with screws to ensure permanent attachment (Fig. 37-11).

5.2.4(h) Component sealing

5.2.4(h1) All penetration points shall be made watertight.

5.2.4(h2) Provide additional sealing with elastomeric sealant or putty tape a minimum of ⅛" thick between the component and the mounting surface.

5.2.4(h3) See (Fig. 37-12)

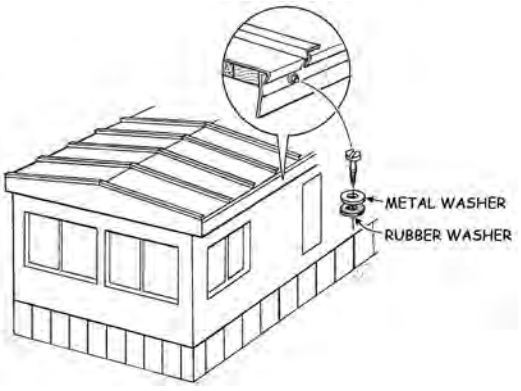


Fig. 37-11: Attachment of Metal Edging

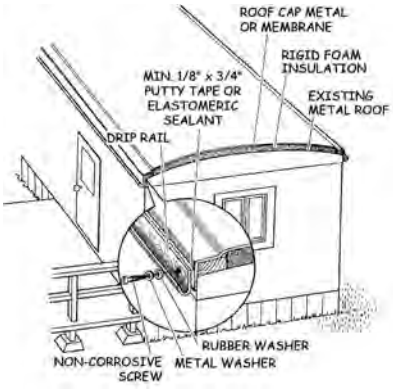


Fig. 37-12: Roof Edge Component Reassembly and Sealing

5.2.4(i) Gas and solid fuel appliance vents and flashings

5.2.4(i1) Correct existing, non-conforming conditions.

5.2.4(i2) Plumbing vent pipes shall extend a minimum of 2" above the surface of the roof cap (Fig. 37-13).

5.2.4(i3) Properly reinstall evaporative coolers.

- The plenum shall extend sufficiently through the roof cap to facilitate installation of a watertight seal.
- Install all mounting hardware in a manner which provides adequate support and a watertight seal at the surface of the new roof cap.

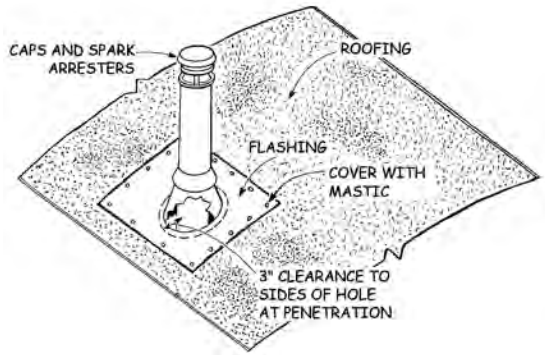


Fig. 37-13: Gas and Solid Fuel Vents and Flashings

5.2.4(j) Roof cavity ventilation

5.2.4(j1) Existing roof vents (e.g., gable vents) shall be tightly blocked and sealed (Fig. 37-14).

5.2.4(j2) Ventilated walls

- Bypasses into roof cavities at the top of ventilated walls shall be blocked.
- The top and bottom of ventilated walls shall not be caulked or blocked.

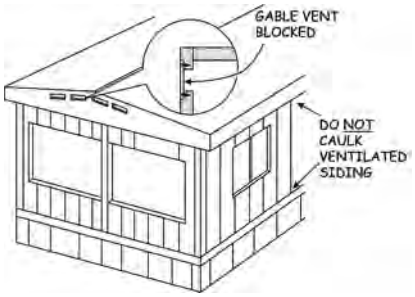


Fig. 37-14: Blocked Roof Vents

5.2.5 Gable End Method

5.2.5(a) Gable end insulation is used to fill the area immediately adjacent to gable ends where proper distribution can be verified by visual inspection.

5.2.5(b) Exterior surface-mount approach

5.2.5(b1) Insulation materials: Minimum R-11 rigid insulation covered with a watertight metal enclosure

5.2.5(c) Interior truss-mount approach

5.2.5(c1) This approach shall be used only when the gable end siding material can be safely removed and replaced.

5.2.5(c2) Securely install insulation within or behind the exposed gable end framework and replace the gable end siding (Fig. 37-15 and Fig. 37-16).

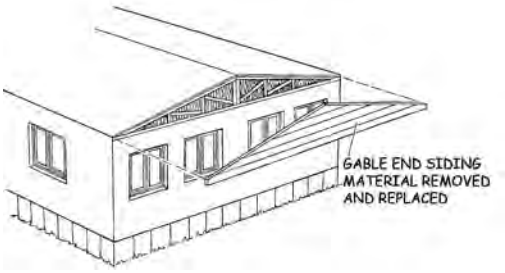


Fig. 37-15: Flexible or Rigid Insulation Installed Within a Truss Frame

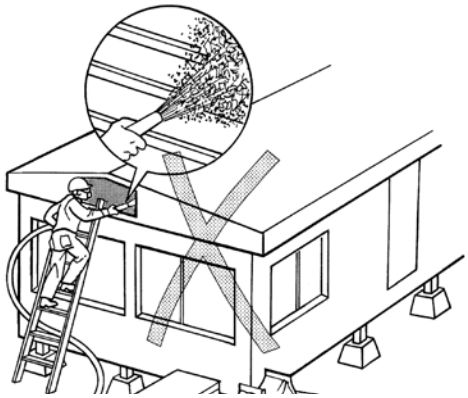


Fig. 37-16: Cross-Blow Is Not Allowed for the Entire Ceiling

5.2.5(d) Gable end cavity fill approach

5.2.5(d1) This approach shall be used only when the ceiling structure is capable of supporting the weight of the added insulation and the blowing pressure.

5.2.5(d2) Insulation shall be loose-fill fiberglass.

5.2.5(d3) Remove siding material or vent grilles or cut/drill holes for access.

5.2.5(d4) Fill the truss cavity immediately adjacent to each gable end with loose-fill fiberglass to create a thermal barrier over the entire gable end.

5.2.5(d5) Return the gable end to a watertight condition with all holes and vents blocked and sealed.

5.2.6 Exterior Roof Edge Cavity Fill Method

5.2.6(a) The roof edge is lifted and temporarily supported to access the truss space where the fill tube will be inserted.

5.2.6(b) Insulation shall be loose-fill fiberglass.

5.2.6(c) Roll-back of metal roofing is not allowed.

5.2.6(d) Utility penetrations and other holes in the top plate shall be sealed while the roof is lifted.

5.2.6(e) Eave vents and wall bypasses that communicate with the roof cavity shall be blocked and sealed.

5.2.6(f) Material placement

5.2.6(f1) Insert the fill tube to within 6" of the end of each ceiling cavity.

- Maximum insulation travel shall be 2' past the end of the fill tube. (Fig. 37-17)

5.2.6(f2) Using the fill tube, fill 100% of each cavity to a consistent density.

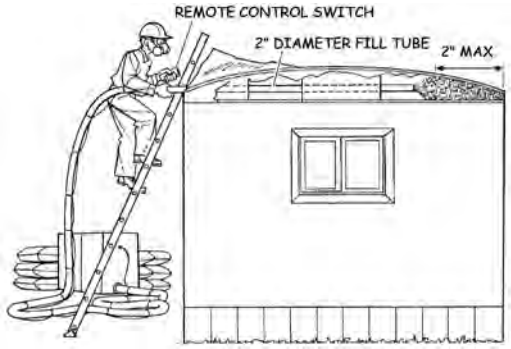


FIG. 37-17: BLOWER MACHINE USE

5.2.6(g) Roofing reassembly

5.2.6(g1) Return metal roofing to its original position and reattach it securely with non-corrosive fasteners (screws, staples, etc.).

5.2.6(h) Reassembly and sealing of roof edge

5.2.6(h1) Replace damaged drip rail, flashing, etc., with compatible materials as needed to ensure proper performance (Fig. 37-12).

5.2.6(h2) Sealing

- Apply sealant between the metal roof and the attached components at all penetration points.
- Apply sealant to exposed seams and screw heads as needed to achieve a permanent, watertight seal.

5.2.7 Interior Ceiling Bore Cavity Fill Method

5.2.7(a) Insulation shall be loose-fill fiberglass.

5.2.7(b) Hole size and spacing

5.2.7(b1) Holes will be large enough to accommodate the chosen fill tube without damaging the ceiling material during installation (≥2" inside diameter [ID], ≤3" ID).

5.2.7(b2) Hole location and size will be placed to provide access to allow for consistent and uniform coverage throughout the ceiling assembly.

5.2.7(b3) Drill equally spaced holes in the ceiling parallel to the exterior wall (except where structural obstructions require alternate spacing).

5.2.7(b4) If a longitudinal ceiling trim piece exists, remove the trim piece and drill holes behind the trim

5.2.7(b5) There shall be at least one hole between each roof truss.

5.2.7(c) Material placement

5.2.7(c1) Fill holes shall extend through the existing vapor barrier and insulation.

5.2.7(c2) Insert the fill tube within 6" of the end of each ceiling cavity.

5.2.7(c3) Using the fill tube, fill 100% of each cavity to a consistent density.

5.2.7(d) Ceiling performance and repair

5.2.7(d1) Correct any excessive ceiling panel stress caused by insulation weight and pressure.

- Tighten loose attachments.
- Install additional attachments as needed to secure ceiling panels to joists.
- Maximum ceiling panel deflection after cavity fill shall be ¼" in 4' of lateral run.
- Reinstall the existing trim if it was removed.

5.2.7(e) Plugs

5.2.7(e1) Custom-made plugs matching the existing ceiling material is a best practice.

5.2.7(e2) Plastic plugs are acceptable.

5.2.7(e3) Seal all plugs in place with caulking, construction adhesive, or other appropriate sealant.

5.2.8 Installation Integrity

5.2.8(a) During the installation process, installers shall verify that damage has not occurred to the roof or ceiling assemblies.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit in a multi-family building will be served, this measure is not feasible.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 Installation (e.g., installation of insulation within the same thermal boundary as dwelling units) is allowed when justified by an energy audit for a whole-building project, per Appendix D Energy Audit/Priority List Protocol.

6.1.4 When adding or replacing HVAC appliances (including a new or fully replaced duct system) in a vented attic consisting of an open space (not intersected by firewalls), insulation must meet installation criteria in Table 37-1.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 To assess for this measure as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.1(a) The form will determine if the measure will be installed in the Audit path or the Priority List (PL) path.

7.1.1(b) When assessing this measure for the Audit path, measure feasibility will be decided by the energy audit with a Measure savings-to-investment ratio (SIR) and Dwelling SIR.

7.1.1(b1) When the measure is feasible based on the audit, and the measure is categorized as a “Major” measure (i.e., Infiltration Reduction, Duct Sealing, Ceiling Insulation, Floor Insulation, and Wall Insulation), the measure shall be installed or the dwelling must be deferred.

7.1.1(c) When assessing for the measure in the PL path, the feasibility will be based on building type and characteristics.

7.1.1(c1) PL measures are classified as Mandatory or Optional based on building type.

- Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.
- Optional measures may be installed only after all feasible Mandatory PL measures have been installed.

7.1.1(c2) This PL measure applies to all dwelling types.

7.1.1(d) When this measure is fully leveraged or co-funded with LIHEAP, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/Priority List Protocol.

7.1.2 If a client refuses a feasible Audit path Major measure, Mandatory Priority List path, or Health & Safety measure, the entire dwelling shall be deferred.

7.1.3 The R-value of added insulation shall be a maximum R-value as set by Table 37-1 or as defined by energy audit.

7.1.4 Attic ventilation will only be installed in conjunction with attic/ceiling insulation.

7.1.5 When installation of ceiling insulation requires IC-rated fixture installation or retrofit of a non-IC-rated fixture with an approved cover/box, the materials and labor shall be billed to the Limited Home Repair-H&S Support line item for DOE WAP jobs.

7.1.5(a) As an incidental repair for DOE WAP, the cost of this work must comply with the incidental repair cost cap considerations as defined in Appendix D Energy Audit/Priority List Protocol.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2(a) Excerpted from 2017 SWS 4.1001.1

7.2.2(a1) A fire-rated air barrier system (i.e., equivalent to ⅝" fire code gypsum wallboard) will be used to separate non-IC rated recessed lights from insulation, using one of the methods below:

- A fire-rated airtight closure taller than surrounding attic insulation will be placed over non-IC rated recessed lights or
- The non-IC rated light fixture will be replaced with an airtight IC-rated fixture or insert or
- The fixture(s) may be replaced with surface mounted fixture and opening sealed or
- Air sealing measures as approved by the authority having jurisdiction

7.2.2(b) Excerpted from 2017 SWS 4.1003.2

7.2.2(b1) Insulation will be verified to prevent visible air movement at 50 pascals of pressure difference using chemical smoke, IR scans, or other approved verification method.

7.2.2(c) Excerpted from 2017 SWS 4.1004.1:

7.2.2(c1) Insulation that is blown behind fabric or air barrier material will be blown dense to a minimum specification of 3.5 pounds per cubic foot for cellulose

7.2.2(d) Excerpted from 2017 SWS 4.1004.4:

7.2.2(d1) Gap between framing and existing air barrier will be insulated

7.2.2(e) Excerpted from 2017 SWS 4.1005.1:

7.2.2(e1) The subfloor or drywall will be removed to access cavities as necessary for installation of insulation, including knee wall and attic floor spaces.

- Exception: When the ceiling structure is damaged or weakened, the enclosed cavity/chase will not be disturbed.

7.2.2(e2) All electrical junctions will be flagged to be seen above the level of the insulation

7.2.2(f) Excerpted from 2017 SWS 4.1005.2:

7.2.2(f1) All insulation will be installed to the minimum unsettled depth and the maximum coverage per bag to reach a consistent depth for desired R-value indicated on the manufacture's coverage chart.

7.2.2(g) Excerpted from 2017 SWS 4.1005.3:

7.2.2(g1) Insulation will not be allowed on top of non-IC rated can light boxes or between a heat generating appliance and a dam, unless material is rated for contact with heat generating sources

7.2.2(h) Excerpted from 2017 SWS 4.1006.1:

7.2.2(h1) Counterweights should be considered to ease accessibility for excessively heavy hatches of disappearing stairs.

7.2.2(i) Excerpted from 2017 SWS 4.1088.1:

7.2.2(i1) Attic ventilation will be recommended or installed if local code requires attic ventilation during weatherization or retrofits

7.2.2(i2) All [ceiling] ventilation will have screens with non-corroding wire mesh with openings of 1/16"–¼" to prevent pest entry (e.g., birds, bats, bees). Note: ⅛"–¼" is recommended.

7.2.2(i3) Ensure net free ventilation area requirements are met.

7.2.3 Mobile Home

7.2.3(a) Excerpted from 2017 SWS 4.1002.2:

7.2.3(a1) Holes, gaps, and penetrations in existing roof deck will be sealed

7.2.3(b) Excerpted from 2017 SWS 4.1003.8:

7.2.3(b1) Loose-fill insulation will be installed to a density of 1.5 to 1.6 pounds per cubic foot

7.2.3(b2) All ventilation systems will maintain a continuous connection and terminate to the outdoors

7.2.3(b3) All plumbing stacks will be terminated to the outdoors

7.2.3(b4) Fasteners will be removed from the J channel and the roof edge on the most easily accessible side of the house

7.2.3(b5) Length of opening will be enough to allow ease of access and reattachment while minimizing potential damage from high winds

7.2.3(b6) If subsheathing is present, access will be gained through subsheathing

7.2.3(b7) Attic will be visually inspected for the location of existing insulation, obstructions, hazards, and construction type

7.2.3(b8) If existing J channel is damaged, it will be replaced

7.2.3(b9) Existing sealant will be removed from the roof edge and J channel

7.2.3(b10) At a minimum, new sealant will be reinstalled at the original location

7.2.3(b11) Roof and J channel will be fastened to the original location with new screws

7.2.3(c) Excerpted from 2017 SWS 4.1003.15:

7.2.3(c1) Non-IC rated light fixtures will be replaced with airtight IC -rated fixtures

7.2.3(c2) All recessed lights will be labeled as having an air leakage rate not more than 2.0 CFM when tested in accordance with ASTM E 283 at a 75 pascals pressure differential

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Combustion appliance safety testing must be performed upon completion of all measures that affect air tightness of home, per Appendix A Combustion Appliance Safety Protocol.

8.1.2 Completed attic sections shall be confirmed to have an even level of insulation at the prescribed R-value in accordance with Table 37-1.

8.1.3 Confirm that damage has not occurred to the roof or ceiling during installation

8.1.4 Once installed, insulation shall not be compressed or scattered, which could impact the efficiency of the insulation R-value.

8.1.5 The clearance zone for HPDs and vents shall be cleared of overblown insulation.

8.2. Client Education

8.2.1 Attic/Ceiling Access

8.2.1(a) The purpose of insulation and proper access operation will be communicated to client.

8.2.2 Disappearing Stairs

8.2.2(a) Educate the client on how to use the access to ensure the integrity of the insulated and sealed assembly throughout its service life.

8.2.2(b) The purpose of the entire measure (insulation, air seal, protective barrier, proper attic stair operation) shall be communicated to client.

8.2.3 Whole House Fan

8.2.3(a) When a whole house fan is present, educate the client on how to use it to ensure the integrity of the insulated assembly throughout the fan's service life and to prevent disturbance of the insulation.

8.2.4 Required Documentation

8.2.4(a) A completed copy of the CSD 610 Insulation Certificate shall be provided to the client.

8.2.4(a1) The certificate shall be completed and signed by the contractor responsible for installing the insulation. The manufacturer, brand, total installed R-value, etc. of the insulation installed in the roof/ceiling, walls, floor, and slab edge shall be documented.

8.2.4(a2) The installer shall also verify compliance with ventilation and infiltration reduction measures for the building envelope.

8.3. Clean-Up and Disposal Requirements

8.3.1 Upon completion, the residence shall be returned to its original condition and left free of job-related dust and debris inside and out.

8.3.2 A HEPA filter vacuum shall be used for all vacuuming.

8.3.2(a) All areas between indoor work areas and the home entrance shall be vacuumed.

8.3.2(b) The area between the home entrance/access and the insulation truck shall be swept or vacuumed.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP:

9.1.1(a) Blown-in/batt—20 years

9.1.1(b) All other types—Not applicable to this measure

9.1.2 DOE:

9.1.2(a) Blown-in/batt—30 years

9.1.2(b) All other types—20 years

9.2 All insulation shall be certified to comply with the material specifications in the California Code of Regulations (CCR), Title 24, Part 12, Chapters 12–13 and “Standards for Insulating Material.”

9.3 Vapor barrier shall be rated no higher than one perm.

9.4 When required as a condition of permit:

9.4.1 Installed IC-rated fixtures must be listed for zero clearance insulation contact, with a label that certifies it as airtight (leakage less than 2.0 CFM at 75 Pascals when tested to ASTM E283).

9.4.2 Installed fixture covers for non-IC-rated fixtures shall be fireproof and listed for the purpose. The covers shall only be used where a non-IC fixture has a thermal switch that disconnects the electricity to the light if the temperature exceeds unsafe levels (e.g., TENMAT® and Insulite® covers).

9.4.2(a) Note: Products that act as dams for can lighting, but do not allow insulation to cover the area over the fixture, are not acceptable.

9.5 Permanent Blocking

9.5.1 Batts: Must comply with American Society of Testing and Materials (ASTM) C665

9.5.2 Non-corrosive metal, minimum 0.007" thick

9.5.3 Commercially available plastic chutes and cardboard baffles (for eave vent chutes and baffles only)

9.6 Mineral Fiber Insulation

9.6.1 Batts and blankets: Must comply with ASTM C665

9.6.2 Loose fill: Must comply with ASTM C764 and ASTM E84

9.7 Cellulose Loose Fill

9.7.1 Must be licensed for sale in California

9.7.2 Must be listed in the Department of Consumer Affairs’ “Directory of Certified Insulation Materials”

9.8 Rigid Insulation

9.8.1 Must be reformed polyisocyanurate board, foil-faced on both sides

9.8.2 Must comply with Federal Standard (FS) HH-1-1972

9.8.3 High-density fiberglass board must comply with ASTM C726

9.9 Access Cover Insulation

9.9.1 Refer to Table 37-1.

9.10 Attic/Ceiling Access Door/Cover

9.10.1 Refer to Section 32 Infiltration Reduction, Material Specifications.

9.11 Strapping material must have a minimum expected service life of 20 years

9.12 Material Specifications for Mobile Homes

9.12.1 All insulation shall be certified to comply with the material specifications in the California Code of Regulations, Title 24, Part 12, Chapters 12–13, Article 3, “Standards for Insulating Material.” In the applicable methods:

9.12.1(a) Loose-fill fiberglass shall comply with ASTM C764 and ASTM E84.

9.12.1(a1) Loose-fill rock wool or cellulose is not allowed.

9.12.1(b) Pre-formed expanded polystyrene foam board shall:

9.12.1(b1) Comply with ASTM C578

9.12.1(b2) Have a minimum density of 1 lb. per cu. ft.

9.12.1(c) Pre-formed foil faced polyisocyanurate or polyurethane foam board shall comply with FS HH-I-1972.

9.12.1(d) All flexible mineral fiber shall comply with ASTM C665.

9.12.1(e) Roof board shall:

9.12.1(e1) Be high-density fiberglass

9.12.1(e2) Comply with ASTM C726

9.12.1(e3) Have a minimum density of 3 lbs per cu. ft.

9.12.2 Synthetic membranes

9.12.2(a) Polyvinyl chloride material

9.12.2(a1) Minimum thickness: 40 mil

9.12.2(a2) Embedded rip-stop fiber scrim required

9.12.2(b) Ethylene propylene diene monomer and Hypalon™ rubber

9.12.2(b1) Minimum thickness: 45 mil

9.12.2(b2) Shall comply with ASTM D4637

9.12.3 Roofing material

9.12.3(a) Aluminum

9.12.3(a1) Materials shall have a minimum thickness of 0.024" for roofing material and 0.019" for gable end enclosures.

9.12.3(b) Steel

9.12.3(b1) Materials shall have a minimum 30-gauge thickness and comply with ASTM A361/361M.

9.12.3(c) Baked-on enamel or equivalent coating is a best practice.

9.12.4 Roof cover material

9.12.4(a) Materials shall be:

9.12.4(a1) Approved and listed by the Department of Housing and Urban Development (HUD)

9.12.4(a2) Approved by the manufacturer for mobile home roof cap applications

9.12.4(a3) Adequately puncture-resistant to withstand the environmental hazards of the location in which it will be installed (e.g., dropping pinecones, tree branches, etc.)

9.12.4(a4) Light in color

9.12.5 Wood edging and furring

9.12.5(a) Redwood or pressure-treated fir is preferred.

9.12.5(b) #2 or better Douglas fir is acceptable.

9.12.5(c) Nominal cross-sectional dimensions shall be minimum 2" x 2".

9.12.6 Metal edging without wooden perimeter

9.12.6(a) Aluminum: 0.028" thickness

9.12.6(b) Galvanized steel: 26 gauge

9.12.7 Metal drip rail, edge trim and flashing, end and ridge caps

9.12.7(a) Aluminum: 0.024" thickness

9.12.7(b) Galvanized steel: 30 gauge

9.12.8 Mechanical fasteners

9.12.8(a) All screws, nails, or staples shall be a minimum of ¾" long and non-corrosive (cadmium-plated or equivalent)

9.12.8(b) All screws shall be #8 minimum size, flathead, and of the proper type and size to ensure a permanent attachment.

9.12.8(c) All washers shall be 3" minimum diameter and contain a center recess to place the screw head flush with or below the insulation surface

9.12.9 Caulking

9.12.9(a) Elastomeric sealant types include polysulfide, polyurethane, and silicone.

9.12.9(a1) Shall comply with ASTM standards for elastomeric sealants (e.g., C920, C603, C734, C1250, and D2202)

9.12.10 Putty tape shall be self-sealing, pliable, and long-life–type adhesive.

10. WARRANTY

10.1 Manufacturer—Limited lifetime

10.2 Contractor—1 year

38. Wall Insulation

Table of Contents

Wall Insulation

1. MEASURE OBJECTIVES

1.1 Wall insulation slows the transfer of heat through the thermal boundary, reducing the amount of heat entering the home on a warm day and the amount of heat loss on a cold day.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 The wall separates conditioned from unconditioned space and

2.2.2 At least 200 sq. ft. of wall area (net area, excluding doors and windows) has R-0 insulation and is feasible to insulate or

2.2.3 Insulation has a savings-to-investment ratio (SIR) ≥1.0 as proven by an energy audit

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The existing insulation R-value is measured to be adequate

3.2 One or more of the following conditions are present and have not been (or cannot be) corrected:

3.2.1 Structural defects exist that cannot be corrected, such as:

3.2.1(a) The need for interior or exterior wall repairs

3.2.1(a1) Substandard interior sheathing (such as ¼" gypsum, ⅛" paneling with 16" on center (OC) framing, ¼" paneling with 24" OC framing, etc.)

3.2.1(a2) Substandard exterior sheathing (such as deteriorated lap siding, wood shingles/shakes, or other conditions that may not withstand the pressure of blown insulation)

3.2.2 There are water leaks or evidence of ongoing leakage

3.2.3 A combustion appliance safety (CAS) hazard or CAS fail exists per Appendix A Combustion Appliance Safety Protocol

3.2.4 Hazardous materials are present

3.2.5 Knob-and-tube (K&T) wiring is present in the walls

3.3 Installation would be in one or more Restricted Locations.

3.4 Installation would violate the Appendix E Health and Safety Requirements

3.5 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 This measure is a whole-building measure. In single-family dwellings (1-4 units) and multi-family buildings (with 5+ units), the whole building must be is served for wall insulation to be installed. See Appendix D Energy Audit/Priority List Protocol.

4.1.2 Audited Measures

4.1.2(a) When this measure will be installed under the Low Income Home Energy Assistance Program (LIHEAP) and an energy audit is performed, if the measure will be fully leveraged or co-funded, it must comply with Appendix D Energy Audit/Priority List Protocol.

4.1.2(b) When this measure is paid for by LIHEAP, or is co-funded with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply.

4.1.3 Fire Hazards

4.1.3(a) If existing insulation is a potential fire hazard due to insulation covering heat-producing devices (HPDs) or combustion ventilation air (CVA) vents, these fire hazards shall be corrected by field personnel. See Section 1 General Installation Guidelines, Fire hazards and venting obstructions.

4.1.4 All air leakage locations (including duct and shell leaks), and thermal bypasses in the walls) shall be sealed prior to installation of insulation per Section 32 Infiltration Reduction and Section 8 Ducting Repair, Sealing and Insulation.

4.1.5 Cavities will be free of hazards, intact, and able to support dense pack pressures.

4.1.6 Restricted Locations

4.1.6(a) Insulation shall not be installed in wall cavities that:

4.1.6(a1) Contain a service entrance, meter base, and/or distribution panel

4.1.6(a2) Contain a gas wall furnace

4.1.6(a3) Contain an electric wall heater or other HPD without full dimensional blocking and a 3" clearance zone or sealed protective pan.

4.1.6(a4) Contain an exhaust fan housing that is not a sealed unit

4.1.6(a5) Contain a metal chimney, flue, or recessed light fixture without a solid barrier and 3" clearance zone

4.1.6(a6) Contain a recessed shelf (insulate only above and below the shelving unit)

4.1.6(a7) Are used as, or contain, a heating, ventilation, or air conditioning duct

4.1.6(a8) Are open to an uninsulated soffit with a recessed light fixture that cannot be properly blocked

4.1.6(a9) Are adjacent to a masonry fireplace or chimney with less than 3" of clearance between the flammable insulation and masonry

4.1.6(a10) Are connected to an unprotected pocket door cavity (i.e., locations where blown insulation can enter the door pocket [Fig. 38-1])

4.1.6(a11) Are open on the interior (e.g., there is incomplete sheathing inside a cabinet, under a sink, etc.)

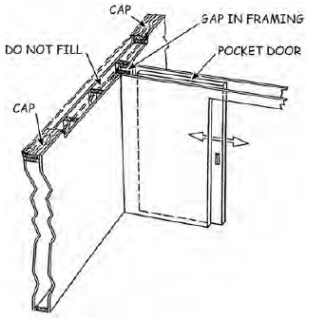


Fig. 38-1: Wall Cavity Connecting with Pocket Door Cavity

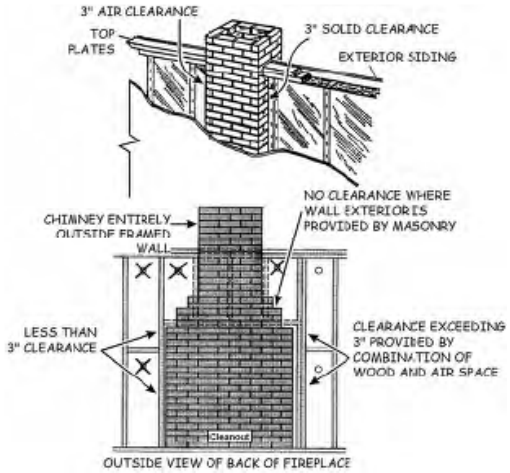


Fig. 38-2: Proper Clearance for Masonry Fireplace or Chimney

4.1.7 Electrical Wiring

4.1.7(a) Look for evidence of substandard wiring in the walls to be insulated.

4.1.7(b) Check for evidence of unsafe wiring at the service entrance and subpanels.

4.1.7(c) Remove at least one cover plate on each wall and check for evidence of unsafe wiring.

4.1.7(d) Identify and mark each cavity where it is unsafe to insulate.

4.1.8 Masonry Fireplaces or Chimneys

4.1.8(a) Cavities containing a masonry fireplace or chimney may be insulated if proper clearance is provided (Fig. 38-2).

4.1.8(b) For cellulose:

4.1.8(b1) A 3" clearance is required between cellulose and masonry

4.1.8(b2) The clearance must be provided by solid wood or a combination of wood and air space

4.1.8(c) For fiberglass, no clearance is required.

4.1.9 Follow the safety practices prescribed in the Appendix E Health and Safety Requirements, Asbestos Policy when asbestos-containing materials or lead-based paint are known or suspected to be present in/on wall sheathing.

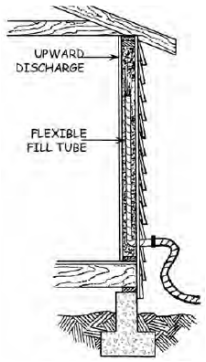


FIG. 38-3: FILL TUBE METHOD

4.1.10 Methods of Installing Pressure-Fill Insulation

4.1.10(a) Fill tube method—Exterior and top-fill wall installation

4.1.10(a1) A fill tube is required when insulation travel must exceed nozzle fill insulation travel maximums.

4.1.10(a2) Top-fill and bottom-fill are acceptable; top-fill is preferred.

4.1.10(a3) All fillable portions of cavities shall be completely filled (Fig. 38-3).

4.1.10(a4) The hole size shall be no more than ½" larger than the fill tube outside diameter.

4.1.10(a5) Fill cavities to the required density, as prescribed by the insulation manufacturer, to achieve the required R-value.

4.1.10(a6) Dense pack requirements:

- Install cellulose material to a minimum density of 3.5 pounds at 50 pascals per cu. ft. as measured using Building Performance Institute (BPI) 102 “Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications—Material Specification” or American Society of Testing and Materials (ASTM) C 522, E 283, or E 2178.
- Install loose fiberglass material specifically approved for airflow resistance to a minimum density of 1½–2 lbs. per cu. ft.
- Confirm that the number of bags installed matches the number required on the manufacturer's coverage chart.

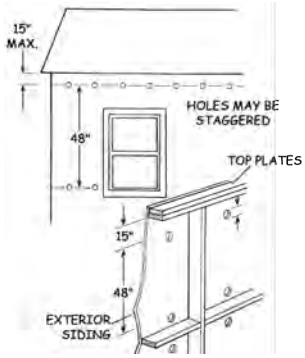


FIG. 38-4: NOZZLE FILL METHOD

4.1.10(b) Nozzle fill method—Exterior and interior wall installation

4.1.10(b1) Use a directional nozzle to direct the flow of insulation (Fig. 38-4).

- Exception: A straight nozzle is allowed when, due to the characteristics of the blowing equipment, a higher density fill can be achieved with a straight nozzle than with a directional nozzle.

4.1.10(b2) Completely fill all portions of all fillable cavities to required density, as prescribed by insulation manufacturer, to achieve the required R-value.

4.1.10(b3) Fill hole size shall conform with manufacturer’s specifications.

4.1.10(b4) Insulation travel maximums:

- Downward 48"
- Upward 15"

4.1.10(b5) Fill all cavities large enough to be drilled.

4.1.11 Required R-Values

4.1.11 (a) For all California Energy Commission (CEC) climate zones, R-value shall be installed in accordance with Table 38-1.

TABLE 38-1: INSULATION R-VALUE CRITERIA

Framing Type	Existing Insulation Level	Action
2x4	R-0	Increase to R-13
2x6	R-0	Increase to R-19

4.2. Installation Procedure

4.2.1 Preparation

4.2.1 (a) Before beginning an installation, the assessor shall inform the client of the inconvenience that may result and the condition in which the home will be left.

4.2.1 (b) Protection of the dwelling and its contents

4.2.1 (b1) Remove wall hangings and other items that may be jarred loose during pressure-filling.

4.2.1 (b2) Inspect all interior wall coverings and trim to make sure they are securely fastened to the wall.

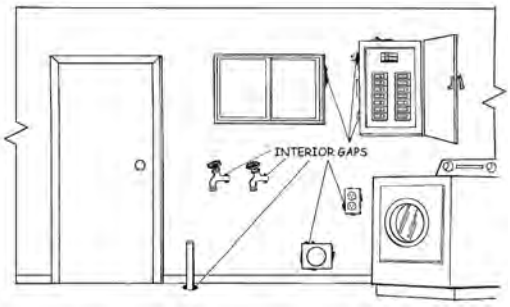


FIG. 38-5: INSULATION WILL LEAK THROUGH INTERIOR GAPS

- Re-set any loose nails and screws.
- Identify any areas of weakness where care must be taken while installing insulation.

4.2.1 (b3) Repair gaps and openings to prevent loose fill from entering the living space (Fig. 38-5).

- Caulk cracks and small holes, including plumbing and electrical penetrations.
- Repair large holes in interior surfaces (such as missing sheathing in cupboards and behind large appliances).

4.2.1 (b4) When insulation is to be installed from the exterior:

- Carefully tie back shrubs/bushes as needed to access the full length of all wall cavities.
- When a garden is next to the home, make all feasible preparations to avoid damaging the plants (e.g., laying down planks to walk on, covering plants with plastic, etc.).
- To catch debris, place a cover (plastic sheeting, tarps, etc.) over the ground, starting at the edge of the wall and extending outward at least 12' (where possible).

4.2.1 (b5) When insulation is to be installed from the interior:

- Move furniture and home furnishings as needed to access the interior side of the walls (after obtaining the occupant's permission).
  - It is not necessary to move furniture that:
    - Is heavy and/or very difficult to move
    - Contains delicate belongings (e.g., a china hutch), unless the occupant removes the items that could be easily damaged
  - Cover furniture, appliances, electronic devices, etc. to protect them from dust.
  - Protect the pathway from the entrance door to the points of insulation with runners.

- Exercise care to prevent damage to the home and furnishings by the loose fill insulation hose, ladders, dust, etc.

- Cupboards and closets
  - Access cupboards and closets as needed to pressure-fill the wall cavities inside them.
  - Personal belongings must be removed by the occupants (or by crew with permission from the occupant) to allow access.

4.2.2 Drill and Fill Precautions

4.2.2(a) When insulation will be installed from the exterior:

4.2.2(a1) Drilling hazards (e.g., wiring, venting, fuel piping) must be located

4.2.2(a2) The following exterior wall material shall not be drilled:

- Asbestos shingles and siding
- Metal siding
- Vinyl siding
- Brick
- Stone
- Adobe
- Exposed surfaces of wood shingles.
  - It is acceptable to remove the outermost shingle, drill and patch the weather-protected surface below, and reinstall or replace the outer shingle.

4.2.2(a3) Do not drill holes in shutters, facing, or trim.

4.2.2(a4) If wall contains lap siding or shingles, carefully unhook or remove one row.

4.2.2(a5) Drill the sheathing as needed and probe to locate each cavity, wall stud, and blocking.

4.2.2(a6) Drilled holes will be large enough to accommodate an appropriately sized fill tube.

4.2.2(a7) Drill holes around the perimeter of the home:

- Parallel to the bottom plate under the lowest windowsill, when possible, an equal distance apart.
- Elsewhere as needed to reach cavities created by fire blocks and bracing

4.2.2(b) When insulation will be installed from the interior

4.2.2(b1) Only gypsum (drywall and plaster) and wooden wall sheathing shall be drilled.

4.2.2(b2) Take all reasonable precautions to minimize the generation of dust inside the home and to capture the dust that is created.

- Cut batts (e.g., for blocking open-top soffit walls) outdoors.
- Place a catch bag or high-efficiency particulate air (HEPA) filter vacuum beneath the drill to catch falling debris as holes are drilled.
- The hole size shall be no more than ½" larger than the fill tube outside diameter.
- Vacuum away dust as it occurs.
- Match the inside diameter of the hole as closely as possible to the outside diameter of the nozzle.
- Wrap a cloth or other protective material around the nozzle to catch dust that blows out around the nozzle.
- After each cavity is filled, turn off the blower and close the nozzle valve before removing the nozzle from the wall.

4.2.3 Installing Insulation

4.2.3(a) Insulation blower set-up

4.2.3(a1) If the blowing machine is not truck-mounted, place it and the bags of insulation on tarps.

4.2.3(a2) Perform a blowing machine pressure test with the air on full, feed off, agitator running, and gate closed.

4.2.3(a3) If the site electrical supply is inadequate, use a portable generator.

4.2.3(a4) Set the hose outlet pressure to at least 80 inches of water column (IWC) or 2.9 lbs. per sq. in. (psi) for cellulose insulation. For other types of dense pack insulation, check manufacturer's specification for blowing machine set-up.

4.2.3(b) Cavities created by fire blocks and bracing

4.2.3(b1) Holes shall be drilled above and below all fire blocks and full-dimension cross braces to ensure that all portions of the wall are filled.

4.2.3(b2) Fill tube method

- A single hole may be drilled at the top or bottom of each portion of the cavity that is above and below the fire block or brace.

4.2.3(b3) Nozzle method

- A minimum of two holes are required for each cavity exceeding 63" in height.

4.2.3(c) Walls open to attic or crawlspace (balloon-framed)

4.2.3(c1) Block cavities with flexible batt material at both top and bottom, prior to injecting insulation through the wall.

4.2.3(c2) Bottom blocking shall be permanently secured to prevent insulation leakage.

4.2.3(d) Attic open to uninsulated soffits

4.2.3(d1) Refer to Section 37 Attic and Ceiling Insulation

4.2.3(e) Walls open to suspended ceilings

4.2.3(e1) Walls below a suspended ceiling

- Insulate the portion of the wall extending from the floor to the suspended ceiling with loose fill material.
  - Fill cavities through the open top with a fill tube or
  - Fill through side holes when cavities are blocked at the level of the suspended ceiling (to prevent loose fill from blowing onto the suspended ceiling).

4.2.3(e2) Walls above a suspended ceiling

- Insulate with flexible batt material.

4.2.3(f) Batt insulation of unfinished framed walls

4.2.3(f1) Batt placement and attachment

- The batts shall completely fill each cavity.
- Friction-fit batts may be installed without staples.
- Batts with a stapling flange shall be face stapled.
- The batts shall not be compressed.

4.2.3(f2) Vapor barrier

- Above-grade walls
  - Faced batts must have a facing rated ≤1 perm that is installed on the winter warm side.
  - Unfaced batts must have a vapor retarder installed on the winter warm side when required by the local jurisdiction.
- Below-grade walls (heated basement, etc.)
  - Vapor retarder placement shall be determined by a site-specific analysis of the factors governing moisture migration and conform with the local jurisdiction.

4.2.3(f3) Insulation of small cavities

- Flexible batts and rigid foam
  - Insulate all cavities around windows and doors.
  - Cut insulation to fit snugly without compression.
  - Do not insulate cavities containing sash weights.

4.2.3(f4) Insulation around pipes

- Flexible batts and rigid foam
  - Do not isolate pipes from the heated side.
  - In locations without freezing temperatures, pipes may be surrounded with insulation.
  - In locations with freezing temperatures, place insulation between pipes and the cold side.
    - Locations with freezing temperatures are those with a winter design temperature listed at or below 32°F in the CEC Reference Appendices or per the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE).

4.2.4 Filling and Patching Walls

4.2.4(a) Stucco, plaster, and gypsum walls

4.2.4(a1) Install backing material in each hole to control the patch depth and isolate the patch from the insulation.

- Backing shall be foam backer rod, or equivalent.

4.2.4(a2) Holes shall be patched and primed.

- Exception: Holes in interior unpainted gypsum (e.g., garage walls)
  - Primer is not required for filler material.
  - Flush mount plastic plugs are allowed when approved by the owner.

4.2.4(b) Wood walls

4.2.4(b1) Painted walls

- Plugs shall be used and shall be recessed at least ⅛" or the depth specified by the filler manufacturer
- Filler/patch shall be sealed with an appropriate primer.
  - Application of a separate primer is not required when a program-approved, self-priming filler is used.

4.2.4(b2) Natural finish walls

- Plugs are required and shall be:
  - Made of wood which is compatible with siding.
  - Installed flush with the siding or sanded flush
  - Secured permanently with exterior-grade adhesive
  - Sealed against water damage

4.2.4(c) Holes in moisture barrier

4.2.4(c1) When siding is removed, patch all breaches in the moisture barrier.

4.2.4(c2) Patching material shall have an equivalent perm rating.

4.2.4(d) Reinstall or replace the siding boards or shingles (if applicable)

4.2.4(d1) T-111 and equivalent siding

- This method may be used when all holes can be in perfect horizontal lines at acceptable distances below the top of the wall, and only when written consent is obtained from the owner:
  - Install a primed trim board centered over the holes.

- The height of the trim will span from 1" above to 1" below the hole.
- Apply a continuous caulk seal above the holes and between the trim and the siding.
- Seal the top edge of the trim to the siding with a continuous caulk seal.

4.2.4(e) Painting over patches

4.2.4(e1) In addition to filling, patching and priming walls that have been drilled for insulation, the patched areas may be painted ("touched up") at the agency's discretion under Limited Home Repair. Refer to Section 1 General Installation Guidelines, Limited Home Repair.

- Touch-up paint must closely match the color of the remainder of the wall.
  - An exact match to the existing paint is not required.
- Painting over patches does not entail repainting the entire wall.

4.2.5 Insulation Certificate

4.2.5(a) An insulation certificate (CSD 610 Insulation Certificate) shall be completed and signed by the contractor responsible for installing the insulation.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

5.1.2 Before installing this measure, prior approval must be granted from the California Department of Housing and Community Development (HCD), or another authority having jurisdiction.

5.1.3 Wall Cavity Assessment

5.1.3(a) Wall cavities will be assessed for the following and, where necessary and feasible, problems will be corrected before work begins:

5.1.3(a1) Drilling hazards (e.g., wiring, venting, fuel piping)

5.1.3(a2) Moisture damage

5.1.3(a3) Presence of infestation or pests

5.1.3(a4) Location and integrity of wiring

5.1.3(a5) Holes to the interior and exterior

5.1.3(a6) Loose paneling or siding

5.1.3(a7) Location of belt rails

5.1.3(a8) Location of wall obstructions (switches, outlets)

5.1.3(a9) Existing insulation

5.1.3(a10) Wall hangings for removal during work

5.1.3(b) Problems will be corrected before work begins.

5.1.3(c) Drilling hazards (e.g., wiring, venting, fuel piping) shall be identified.

5.1.4 Electrical Wiring Verification

5.1.4(a) To the extent possible, inspect for unsafe wiring before removing metal siding beyond what is needed for inspection/evaluation and before removing existing insulation (when doing so is necessary to install new insulation).

5.1.4(a1) Indoors:

- Remove at least one receptacle and one switch cover plate on each wall.
- Inspect the wiring for loose connections, faulty conductors, or other unsafe conditions.
- Leave the cover plates off until the new insulation has been installed.

5.1.4(a2) Outdoors:

- Remove a sufficient number of fasteners to allow for inspection. (See Removal of fasteners.)
- Inspect the wiring by pulling back the siding and pushing the existing insulation out of the way from below.
- If the cavity will be insulated, leave the fasteners out.
- If the cavity cannot feasibly be insulated, install new fasteners to secure the siding. (Existing screws are not reinstalled.)

5.1.4(a3) If there is evidence of unsafe or hazardous wiring:

- Do not install new insulation in that cavity and do not remove the existing insulation.
- Mark the cavity on the outside as being not safe to insulate.
- Explain the reason for not insulating that cavity in the job paperwork.

5.1.5 Indoor Preparation for Mobile Home Insulation

5.1.5(a) After obtaining the client's permission, move the furniture as needed to access the interior side of all walls to be insulated.

5.1.5(b) It is not necessary to move furniture that:

5.1.5(b1) Is heavy and very difficult to move

5.1.5(b2) Contains delicate belongings (e.g., a china hutch), unless the client removes the items that could be easily damaged

5.1.5(c) Mask areas that may cause dust to spread on the interior.

5.1.5(d) Remove pictures and wall hangings as well as nails, screws, hooks, etc. that penetrate the wall paneling.

5.1.5(e) Inspect all paneling and trim to make sure they are securely fastened to the wall.

5.1.5(e1) Drive home any loose nails and screws.

5.1.5(e2) Identify any areas of weakness where care must be taken while installing insulation.

5.1.5(e3) Identify each location where it is unsafe to install insulation.

- Mark the cavity on the outside as being not safe to insulate.
- Describe location and explain the reason for not insulating that cavity in the job paperwork.
- Caulk cracks and small holes, including plumbing and electrical penetrations, and repair large holes in interior surfaces to prevent indoor air from entering the wall cavity.

5.1.5(f) Electrical boxes (switch and receptacle)

5.1.5(f1) Determine if the electrical boxes can be easily removed and remove them, if feasible, until after insulation has been installed.

5.1.5(f2) Remove screws from the boxes and pull the boxes out of the wall temporarily so they will not obstruct batt stuffing.

5.1.5(f3) Do not remove boxes that cannot be reinstalled and securely refastened.

5.1.5(g) Blocking

5.1.5(g1) Install blocking around:

- All openings into the undercarriage area and mobile home roof
- High-temperature, fire-rated materials
- Wiring and electrical hazards
- HPDs

5.1.6 Outdoor Preparation for Mobile Home Insulation

5.1.6(a) Accessing wall cavities

5.1.6(a1) Drill sheathing as needed and probe the cavity to locate each cavity, wall stud, and blocker.

5.1.6(a2) When accessing wall cavities, mask the interior of the home to control dust during drilling.

5.1.6(b) Carefully tie back shrubs/bushes as needed to access the bottoms of all wall cavities.

5.1.6(c) When a garden is next to the mobile home, make all feasible preparations to avoid damaging plants (e.g., laying down planks to walk on, covering plants with plastic, etc.).

5.1.6(d) When outdoor steps for an entrance door interfere with siding access, temporarily remove the steps if permission is given by the client.

5.1.6(e) If a deck or other obstruction prevents access to any siding panels:

5.1.6(e1) Bypass those panels, and

5.1.6(e2) Describe the location and explain the reason for not insulating those cavities in the job paperwork.

5.1.6(f) To catch debris, place a cover (plastic sheeting, tarps, etc.) over the ground, starting at the edge of the skirting and extending outward at least 12'.

5.1.6(g) If not truck-mounted, place the blowing machine and bags of insulation on tarps.

5.2. Installation Procedure

5.2.1 Mobile Home Installation Methods

5.2.1(a) Batt “stuffing” method

5.2.1(a1) Wood siding

- Follow the applicable criteria for conventional homes.

5.2.1(a2) Metal siding

- Installation shall be attempted only when the depth of the stud cavity allows for the installation of new, 3½"-thick, high-density fiberglass blankets/batts.
- Until it has been determined that wall insulation is feasible for the mobile home, siding removal is limited to what is necessary to establish feasibility.
  - Mobile homes built after 1976 have 3½"-thick wall studs, which can accept retrofit 3½"-thick batts.
  - Pre-1976 mobile homes may have 2½"-thick wall studs and/or ventilated metal siding and shall not be insulated when ventilated metal siding is present.
    - When installed, new insulation will be made to fit the size of the cavity.
    - Existing insulation shall be removed only when necessary to allow for installation of new high-density batts.
  - Very old mobile homes may have 1½"-thick studs and/or ventilated metal siding.
    - Retrofit wall insulation is not feasible.
- Fabricate a stuffing tool (used to push the fiberglass insulation into an enclosed wall cavity) made with a strip of polycarbonate (e.g., Lexan), approximately 5⁄16" thick
  - Do not use other clear sheet plastics due to a tendency to shatter under stress.
  - Dimensions:
    - 1' wide by 8' long for full-length cavities
    - 1' wide by 4' long for shorter cavities (under windows, etc.).
    - Bent at a 5°–15° angle, 7½"–12" from one end.

        - For plastic, apply indirect heat at the bend location to achieve the angle.
      - Round all corners and sand all edges of the polycarbonate
- Removal of fasteners
  - Access the bottom of metal siding—vertical panels
    - If skirting overlaps siding, skirting will be detached to allow access to the wall cavity.
    - Remove metal siding fasteners until the siding can be pulled away from the framing approximately 6" without damaging the siding).
      - Remove the bottom two rows of screws.
      - When full-length panels are secured to the framing with staples (approximately 4' up the wall cavity), remove the staples (e.g., with a long pry bar).
- Fasten adjacent panels together at the bottom with one ½" sheet metal screw on each side.
  - These screws keep panels from pulling apart sideways when they are pried away from the framing to insert insulation.
  - These screws are especially important for interlocking panels.
- Remove the perimeter flashing (fascia strip) below the bottom of the siding.
  - Remove the flashing if it is secured with screws removed from the bottom of siding panels and if removal is necessary to facilitate installation of new insulation batts.
  - If removed, mark each piece so it can be replaced in the location from which it was removed.
- Access the bottom of metal siding—horizontal panels
  - Remove the bottom section of the siding to gain access to the wall cavities.
  - If sub-sheathing is present under the siding, access through the sub-sheathing will be required.
- Examine Wall Cavities
  - Remove the existing insulation.
  - Before installing new insulation, inspect the interior of each wall cavity for moisture damage, deterioration, obstructions, and adequate accessibility.
  - Inspect all interior surfaces of outside walls for loose paneling joints, occupant wall hangings, locations of switches and outlets, and other wall obstructions.
  - Remove objects from the interior surfaces of the walls being insulated.
  - Repair interior paneling as necessary.
  - If the framing and interior paneling are intact and electrical wiring or water pipes do not pose a problem, proceed with the insulation procedure.

5.2.1 (a3) Installation of new blanket/batt insulation

- Blanket/batt insertion
  - Insulation length: 8" longer than the height of the cavity being stuffed.
  - The thickness of the batt should fill the void without deforming the siding or damaging the structure.
  - A poly-encased fiberglass batt may be used in place of the fiberglass batt and membrane assembly.
  - The membrane will be installed in contact with the side of the wall that is compatible with the local climate zone (winter warm side).

- Membrane (plastic sheeting):
  - Cut the plastic sheeting 2" wider than the cavity and 1' longer than the batt. (It is required to facilitate sliding the batts up into the wall cavities.)
- Place the unfaced blanket/batt on top of the plastic membrane.
- Place the stuffing tool (of the appropriate length) on top of the batt with the angled end facing upward.
- Fold the first 6" of plastic membrane and fiberglass batt over the angled end of the stuffing tool.
- Pull the metal siding outward and away from the wall framing.
- Put the side of the batt with the plastic membrane against the interior paneling. (The stuffing tool is on the outer surface of the batt.)
- Using the stuffing tool to push the batt upward:
- Stuff the insulation into the wall cavity all the way to the top
  - If obstructions impede movement, work the tool to get past them
  - After the batt reaches the top of the cavity, pull the stuffing tool back down and out of the wall.
- Allow the extra length of batt to hang below the siding to identify the cavities that have been stuffed. (Do not stuff the bottom ends of the batts into the wall cavities until after all cavities have been insulated.)
- Repeat the stuffing procedure for each accessible cavity.

5.2.1(a4) Interior observation

- As insulation is stuffed into a cavity or the cavity is pressure-filled, the location must be observed from the inside so appropriate action can be taken if paneling is being bulged out or pushed loose.

5.2.1(a5) Wall closure after insulation is completed

- At each wall cavity where the extra length of a batt is hanging below the siding:
  - Push the batt into the bottom of the wall cavity to fill and insulate it
  - Press the siding panels back into place, making sure they interlock as designed

5.2.1(a6) Repair subsheathing as necessary.

5.2.1(a7) Replace the perimeter flashing (fascia strip), if removed.

5.2.1(a8) Reattached the siding in the original position without bulges or wrinkles.

5.2.1(a9) Install new screws that are longer and thicker than the original screws in all screw locations to tightly secure the panels in place. (Do not reuse the original screws.)

5.2.1(a10) If skirting was removed, reinstall to shed water to the outside of the skirting.

5.2.2 Limited Access Procedures—Blanket/Batt Insertion

5.2.2(a) If a condition in the wall cavity makes it unsafe or unfeasible to safely and properly install new batts:

5.2.2(a1) Cut the batt narrower or shorter so it will fit in the available area or

5.2.2(a2) Bypass that cavity, describe the location, and explain the reason for not insulating it in the job paperwork.

5.2.2(b) Cavities with electrical wiring and plumbing

5.2.2(b1) Insulate the cavity only when wiring and plumbing defects are not present.

5.2.2(b2) Take appropriate precautions to avoid damaging wiring or piping.

5.2.2(c) Cavities with window, fan, or other obstruction

5.2.2(c1) Stuff the insulation up to the obstruction.

5.2.2(c2) When the bottom of siding panels above a window/obstruction can be accessed (screws removed and paneling pulled away) without removing the window/obstruction, fill those cavities the same as siding panels accessed from floor level.

5.2.2(c3) When siding panels above a window/obstruction cannot feasibly be accessed from the bottom, access them from the top:

- Remove the screws at the top of the panels.
- Remove the drip edge and/or other components as needed to access the cavities from the top.
- Pull back the panels and stuff the batts downward to fill the cavities.
- Reinstall the components that were removed.
- Secure the siding and components with new screws that are longer and thicker than the original screws.
- Apply sealant as needed to ensure a watertight seal in all seams/joints/screws where components were removed and replaced.

5.2.3 Limited Access Locations—Pressure-Fill

5.2.3(a) Purpose

5.2.3(a1) To fill cavities in which batt stuffing is not feasible (too narrow, obstructed, or inaccessible), such as:

- Cavities near corners and doors, where siding is difficult to loosen and pull back.
- Cavities that are particularly tight due to belt rails, wiring, windows, and other obstructions.

5.2.3(b) Procedure

5.2.3(b1) If skirting overlaps the siding, remove the skirting.

5.2.3(b2) Loosen the bottom of the wall panel(s) enough for fill tube access.

5.2.3(b3) Temporary fasteners will be installed near the bottom of the siding panels at the seams to keep panels from separating.

5.2.3(b4) If sub-sheathing is present under the siding, access through the sub-sheathing will be required.

5.2.3(b5) Insert the fill tube from the bottom of the wall cavity to within 6" of the top of the cavity between the interior paneling and any existing insulation.

- Position the tube so its natural curvature presses the top of its angle-cut tip against the interior paneling.
- If the tube hits a belt rail or other obstruction, twist the tube slightly to help get it past the obstruction.
- If the wall cavity is known to contain electrical wiring or plumbing, care must be taken to avoid snagging the tube or causing damage.

5.2.3(b6) Place a short piece of batt to block the bottom of the panel access and prevent loose fill from blowing out.

5.2.3(b7) An observer must be stationed indoors during the filling process to watch for paneling bulges and loosening of the edges/trim.

5.2.3(b8) Carefully pressure-fill the wall cavity, using less pressure than for conventional home wall cavity fill.

- Install insulation to a density of 1.5–1.6 lbs. per cu. ft.
- Draw the fill tube downward about 6" at a time when:
  - The blower fan slows down due to back pressure and/or
  - Insulation flow through the hose slows down and/or
  - There is slight bulging of the exterior siding or interior paneling
- Fill 100% of each cavity to a consistent density.
- Immediately turn off the blower or withdraw the tube if the insulation flow stops and/or excessive bulging occurs.
- Avoid over-filling the bottom of the cavity, then stuff the blocking batt in to insulate that area.

5.2.3(b9) Patch and repair the sub-sheathing as necessary.

5.2.3(b10) Remove any loose fill from the outer edges of the studs before securing the metal siding to them.

5.2.3(b11) Reattach the siding without bulges or wrinkles.

5.2.3(b12) Install new screws in all screw locations to tightly secure the siding panels in place. (Do not reuse the original screws.)

5.2.3(b13) If skirting was removed, reinstall the skirting to shed water to the outside.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Procedure

6.1.1 When only an individual multi-family unit in a multi-family building will be served, this measure is not feasible.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 Installation in common areas (e.g., installation of insulation in hallways, a lobby, a shared kitchen, etc. within the same thermal boundary as dwelling units) is allowed when justified by an energy audit for a whole-building project, per Appendix D Energy Audit/Priority List Protocol.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 To assess for this measure as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.1(a) The form will determine if the measure will be installed in the Audit path or the Priority List (PL) path.

7.1.1(b) When assessing this measure for the Audit path, measure feasibility will be decided by the energy audit with a Measure savings-to-investment ratio (SIR) and Dwelling SIR.

7.1.1(b1) When the measure is feasible based on the audit, and the measure is categorized as a “Major” measure (i.e., Infiltration Reduction, Duct Sealing, Ceiling Insulation, Floor Insulation, and Wall Insulation), the measure shall be installed or the dwelling must be deferred.

7.1.1(c) When assessing for the measure in the PL path, the feasibility will be based on building type and characteristics.

7.1.1(c1) PL measures are classified as Mandatory or Optional based on building type.

- Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.
- Optional measures may be installed only after all feasible Mandatory PL measures have been installed.

7.1.1(c2) This PL measure applies to all dwelling types.

7.1.1(d) When this measure is fully leveraged or co-funded with LIHEAP, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/Priority List Protocol.

7.1.2 If a client refuses a feasible Audit path Major measure, Mandatory Priority List path, or Health & Safety measure, the entire dwelling shall be deferred.

7.1.3 The R-value of added insulation shall be:

7.1.3(a) A minimum R-value set by Table 38-1

7.1.3(b) A maximum R-value as defined by energy audit

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2(a) Excerpted from 2017 SWS 4.1101:

7.2.2(a1) Insulation density will be verified by bag count, core sampling, or infrared camera with the blower door at 50 pascals to prevent visible air movement using chemical smoke at 50 pascals of pressure difference.

7.2.2(b) Excerpted from 2017 SWS 4.1103.2:

7.2.2(b1) Interior (drill and fill) holes will be coated and patched to match original interior surface

7.2.2(c) Excerpted from 2017 SWS 4.1402:

7.2.2(c1) Where termite pressure exists, a 3" inspection gap will be maintained from the top of the insulation to the bottom of any wood

7.2.2(c2) A continuous air barrier will be installed on the warm side of the insulation

7.2.2(c3) When absorbent insulation materials are installed, assembly will remain vapor semi-impermeable to the interior in all climate zones except Zone 7

7.2.3 Mobile Home

7.2.3(a) Requirements for mobile homes are the same as those for single-family homes.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Combustion appliance safety testing must be performed upon completion of all measures that affect air tightness of home, per Appendix A Combustion Appliance Safety Protocol.

8.1.2 Pressure-fill insulation

8.1.2(a) During and after installation, the interior of the home shall be checked for wall damage and accidental leakage of insulation material.

8.1.2(b) During and after installation, a representative sample of utility switch/outlet boxes shall be checked for loose fill.

8.1.2(b1) If loose fill insulation is found, check all accessible boxes and remove the insulation.

8.1.2(c) Completed wall insulation cavities shall be confirmed to have an even level of insulation at the prescribed R-value.

8.1.2(d) Interior closets and cupboards shall be checked for loose fill material.

8.1.2(e) All loose fill material accidentally blown into the home shall be removed.

8.1.2(f) All interior and exterior damage caused by insulating shall be repaired.

8.1.2(g) Electrical cover plates removed for inspection shall be reinstalled.

8.1.2(h) Any cover plates damaged or broken during insulation installation shall be replaced.

8.1.2(i) Dense pack verification

8.1.2(i1) The number of bags installed shall be confirmed and shall match the number required on the manufacturer's coverage chart.

8.1.2(i2) Completed wall sections will be viewed using infrared camera with blower door operating

8.1.2(i3) Any voids or low-density areas shall be drilled and re-packed.

8.2. Client Education

8.2.1 A copy of the completed CSD 610 Insulation Certificate must be provided to the client.

8.3. Clean-Up and Disposal Requirements

8.3.1 Upon completion, the residence shall be returned to its original condition and left free of job-related dust and debris inside and out.

8.3.2 A high-efficiency particulate air filter vacuum shall be used for all vacuuming.

8.3.3 Access inside the living space

8.3.3(a) All areas between indoor work areas and the home entrance shall be vacuumed.

8.3.4 Access outside the living space

8.3.4(a) All areas between the access and the insulation truck shall be swept or vacuumed.

8.3.5 Return dwelling to its original state

8.3.5(a) Indoors

8.3.5(a1) Remove coverings (e.g., plastic sheeting) from furniture, appliances, electronic devices, etc.

8.3.5(a2) Remove scraps and debris, and vacuum clean all areas affected by the insulation process.

8.3.5(a3) Return to their original position any household furnishings moved to perform the job.

8.3.5(a4) Outdoors

8.3.5(a5) Untie bushes, etc., and return them to their original condition.

8.3.5(a6) Remove plastic covers from plants and remove walking planks from garden beds.

8.3.5(a7) Remove all leftover insulation, packaging materials, plastic sheeting, insulation scraps, debris, ground covers/tarps, tools, and equipment.

8.3.6 All clean-up materials shall be removed from the premises and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP:

9.1.1(a) Dense pack/rigid/full batt in airtight cavities—20 years

9.1.1(b) All other types—Not applicable to this measure

9.1.2 DOE:

9.1.2(a) Dense pack/rigid/full batt in airtight cavities—30 years

9.1.2(b) All other types—20 years

9.2 All insulation shall be certified to comply with the California Code of Regulations, Title 24, Part 12, Chapter 12–13, “Standards for Insulating Material.”

9.3 Flexible and Rigid Materials

9.3.1 Non-absorbent, fire-rated insulation with a minimum life expectancy of 10 years shall be used.

9.3.2 Flexible mineral fiber shall conform to ASTM C665.

9.3.3 High density fiberglass board shall conform to ASTM C726.

9.3.4 Rigid foam shall be pre-formed, foil-faced polyisocyanurate board that conforms to Federal Specification (FS) HH-I-1972/1.

9.3.5 Facing shall meet applicable code requirements.

9.4 Loose-Fill Materials

9.4.1 Loose-fill fiberglass will meet a flame spread rating of 25 or less and a smoke development rating of 450 or less when tested in accordance with ASTM E84.

9.4.2 Loose-fill mineral fiber shall conform to ASTM C764.

9.4.3 Loose-fill cellulose shall be licensed for sale in California and listed in the Department of Consumer Affairs “Directory of Certified Insulation Materials.”

9.5 Vapor Retarder (Membrane)

9.5.1 Minimum 6-mil plastic sheeting with an appropriate perm rating for the region.

9.6 Filling and Patching/Plugging

9.6.1 Use materials appropriate for the application.

9.6.1(a) Exterior-grade for all exterior applications

9.6.1(b) Compatible with the surrounding material

9.6.1(c) Installed in accordance with manufacturer’s instructions

9.6.1(d) Finished to blend with the surrounding wall

9.6.2 Plugs shall:

9.6.2(a) Be compatible with the siding

9.6.2(b) Not be vented

9.6.2(c) Be resistant to shrinkage and expansion

10. WARRANTY

10.1 Manufacturer—Limited lifetime

10.2 Contractor—1 year

39. Floor Insulation

Table of Contents

Floor Insulation

1. MEASURE OBJECTIVES

1.1 Floor insulation slows the transfer of heat through the thermal boundary, reducing the amount of heat entering the home on a warm day and the amount of heat loss on a cold day.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure.

2.2. Install

2.2.1 The floor separates conditioned and unconditioned space and

2.2.2 At least 100 sq. ft. of floor is feasible to insulate (no functional insulation existing) or

2.2.2(a) If the crawlspace access is uninsulated but the floor has adequate insulation, the cover shall be insulated as a Limited Home Repair - ECM Support item. See Section 1 General Installation Guidelines, Limited Home Repair Policy.

2.2.2(a1) Exception: When insulation is unfeasible due to a safety condition in the crawlspace (e.g., presumed asbestos, knob-and-tube wiring, etc.), insulation shall not be added to the access cover.

2.2.3 Insulation has a savings-to-investment ratio (SIR) ≥1.0 as proven by an energy audit

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 The existing insulation R-value is measured to be adequate

3.2 One or more of the following conditions are present and have not been (or cannot be) corrected:

3.2.1 An exhaust system (including a gas or electric clothes dryer) terminates in the crawlspace and cannot be vented to the outdoors per Section 1 General Installation Guidelines, Limited Home Repair

3.2.2 A combustion appliance safety (CAS) hazard, or CAS fail per Appendix A Combustion Appliance Safety Protocol

3.2.3 Structural defects, such as deteriorated or substandard floor framing or sheathing

3.2.4 Hazardous conditions, such as standing water or sewage, mold, fuel leaks, plumbing leaks, or electrical hazards

3.2.5 Inadequate crawlspace venting that cannot be corrected per Section 41 Crawlspace Ventilation

3.2.6 Knob-and-tube (K&T) wiring is present and has not been certified safe for encapsulation or permanently disconnected by a licensed C-10 electrical contractor, per the Section 1 General Installation Guidelines, Knob & Tube (K&T) Wiring Guidelines

3.3 Installation would violate the Appendix E Health and Safety Requirements

3.4 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Crawlspace ventilation may be installed in conjunction with floor insulation, or as a stand-alone measure, per Section 41 Crawlspace Ventilation, General Requirements.

4.1.2 This measure is a whole-building measure. In single-family dwellings (1-4 units) and multi-family buildings (with 5+ units), the whole building must be served for crawlspace insulation to be installed. See Appendix D Energy Audit/Priority List Protocol.

4.1.2(a) Under the Low Income Home Energy Assistance Program (LIHEAP), when an energy audit will not be conducted, crawlspace insulation may be installed for a unit in a duplex, tri-plex, or four-plex only when there are no shared crawlspaces between dwelling units (i.e., the crawlspaces are separated by a complete and continuous pressure boundary or firewall and the units have separate heating and/or cooling units).

4.1.3 Audited Measures

4.1.3(a) When this measure will be installed under the Low Income Home Energy Assistance Program (LIHEAP) and an energy audit is performed, if the measure will be fully leveraged or co-funded, it must comply with Appendix D Energy Audit/Priority List Protocol.

4.1.3(b) When this measure is paid for by LIHEAP, or is co-funded with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply.

4.1.4 Fire Hazards

4.1.4(a) If existing insulation is a potential fire hazard due to insulation covering heat-producing devices (HPDs) or combustion ventilation air (CVA) vents, these fire hazards shall be corrected by field personnel. See Section 1 General Installation Guidelines, Fire hazards and venting obstructions.

4.1.5 All air leakage locations (including duct and shell leaks, and thermal bypasses in the floor) shall be sealed prior to installation of insulation per Section 32 Infiltration Reduction and Section 8 Ducting Repairs, Sealing and Insulation.

4.1.6 All repairs or installations requiring crawlspace access shall be completed before insulation is installed.

4.1.7 Crawlspace must be accessible in accordance with the clearance requirements for attics and crawlspaces identified in the Section 1 General Installation Guidelines, Attic and Crawlspace Accessibility.

4.1.8 K&T Wiring

4.1.8(a) If a C-10 electrician certifies the K&T wiring is safe for encapsulation, Section 1 General Installation Guidelines, Knob & Tube (K&T) Wiring Guidelines shall apply.

4.1.9 New Insulation

4.1.9(a) New insulation shall be installed according to Table 39-1.

TABLE 39-1: INSULATION REQUIREMENTS IN ALL CLIMATE ZONES

Insulation Criteria	Existing R-Value	Increase to
Floor Insulation	No existing	R-19
Crawlspace Access Cover	No existing	R-19

4.1.9(b) When floor insulation is unfeasible, insulation shall not be added to the access cover as a Limited Home Repair.

4.1.10 Conditions Requiring a Vapor Retarder

4.1.10(a) A vapor retarder shall be installed in conjunction with floor insulation when:

4.1.10(a1) Required by the local jurisdiction

4.1.10(a2) Specified by floor insulation type in this standard

4.1.10(a3) Installed in an unvented crawlspace, unless not required by the local jurisdiction

4.1.10(b) Basements with exposed soil floor shall have ground cover over soil, unless vented and dry, or excluded by local code.

4.2. Installation Procedure

4.2.1 Protection of the Dwelling and Its Contents

4.2.1(a) When crawlspace access is indoors, protect the pathway from the entrance door to the crawlspace access with runners.

4.2.1(b) When entry is through an access inside a closet, remove or cover the clothing and other personal property.

4.2.1(c) Cut batts outside the living space or inside the crawlspace.

4.2.1(d) When carrying batts, enclose batts in plastic or other method to prevent releasing fibers in the living area.

4.2.2 Preparation of Crawlspace

4.2.2(a) Remove all vegetation and organic material, unnecessary material, and debris from the crawlspace (e.g., rake the crawlspace) and dispose of it properly.

4.2.3 Water Pipes and Heating, Ventilation and Air Conditioning (HVAC) Ducts

4.2.3(a) In locations without freezing temperatures, surround the pipes with insulation (Fig. 39-1).

4.2.3(b) In locations with freezing temperatures, place insulation between the pipes and the cold side.

4.2.3(b1) Locations with freezing temperatures are those with winter design temperatures listed at or below 32°F in the California Energy Commission (CEC) Residential Manual, or per the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE).

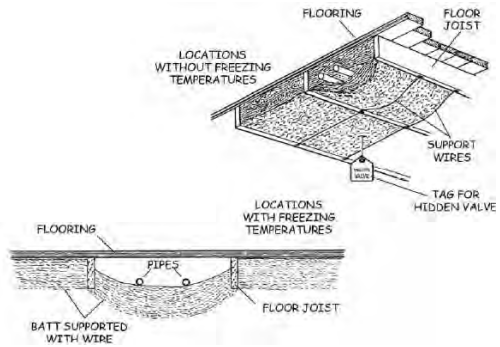


FIG. 39-1: PIPE INSULATION WITH AND WITHOUT FREEZING TEMPERATURES

4.2.3(c) Tag water valves if they are covered by insulation.

4.2.3(d) Installation of water pipe heaters is not allowed.

4.2.3(e) Insulate ducts located within joist cavities in accordance with Section 8 Ducting Repair, Sealing, and Insulation.

4.2.4 Gas Appliances in the Crawlspace

4.2.4(a) Maintain ≥3" horizontal clearance from vent pipes.

4.2.4(b) Maintain ≥6" clearance from draft hood.

4.2.5 Interior Crawlspace Access Cover

4.2.5(a) Flexible or rigid insulation, with an R-value equal to floor insulation, shall be attached to the cover.

4.2.6 Installation of Insulation

4.2.6(a) All insulation types

4.2.6(a1) Insulation shall be installed in contact with the subfloor without gaps, voids, compressions, misalignments, or wind intrusions.

4.2.6(a2) Combustion air supply openings or crawlspace vents shall not be obstructed by insulation.

4.2.6(a3) Maintain minimum 3" clearance from HPDs.

4.2.6(a4) Setback from crawlspace vents (Fig. 39-2):

- 12" clearance without barrier
- 3" clearance with barrier made of corrosion-resistant sheet metal (e.g., 0.007" thick aluminum flashing)

4.2.6(b) Flexible insulation

4.2.6(b1) If faced batts are used, facing is placed against the subfloor.

4.2.6(c) Loose fill and dense pack insulation

4.2.6(c1) A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly.

- Seams and penetrations will be sealed.

4.2.6(c2) Insulation will be installed between the air barrier and the subfloor.

4.2.6(c3) Dense pack of finished floor cavities (blind fill)

- Drill cavities and pressure-fill with loose-fill insulation using a directional nozzle or fill tube.
  - Space holes for maximum 2' horizontal insulation travel beyond the nozzle.
  - Provide 100% coverage at the density prescribed by the manufacturer.
- Fill all portions of fillable cavities completely.
- Plug and patch holes as prescribed in Section 38 Wall Insulation.

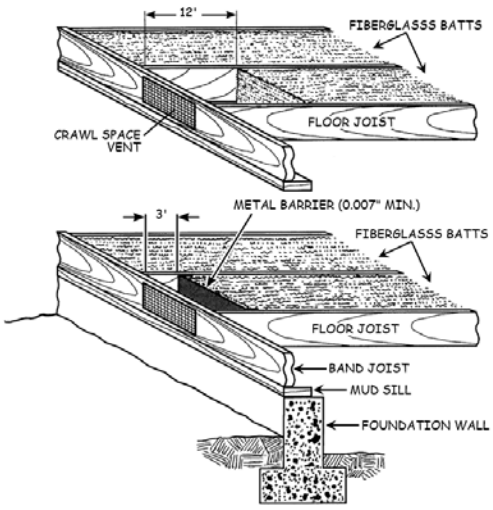


FIG. 39-2: SETBACK FROM CRAWLSPACE VENTS

4.2.6(d) Rigid insulation

4.2.6(d1) Rigid insulation must be mechanically fastened to the bottom of the subfloor or floor joists.

4.2.6(d2) Where rigid insulation is installed between joists (bottom of the subfloor), air seal the perimeter of each joist bay.

4.2.6(d3) Rigid foam plastics used as insulation shall incorporate a thermal and ignition barrier as required by local building code.

4.2.6(d4) A continuous air barrier must be installed below the insulation and to the exterior.

4.2.7 Supports and Anchors for Flexible Insulation

4.2.7(a) Size and space all support types so insulation does not sag and lose contact with sheathing (Fig. 39-3).

4.2.7(b) Install supports with 10% maximum compression of insulation.

4.2.7(c) Spring wire support rods ("lightning rods")

4.2.7(c1) Rods shall be:

- Cut to length for proper support without excessive compression
- Installed under pressure, with minimum 1⁄16" joist penetration
- Arched upward
- Placed within 4" of each end of a batt and spaced elsewhere a maximum of 18" apart

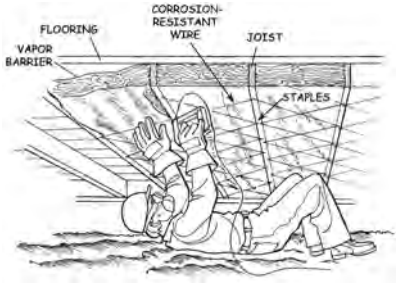


FIG. 39-3: SUPPORTING FLEXIBLE INSULATION

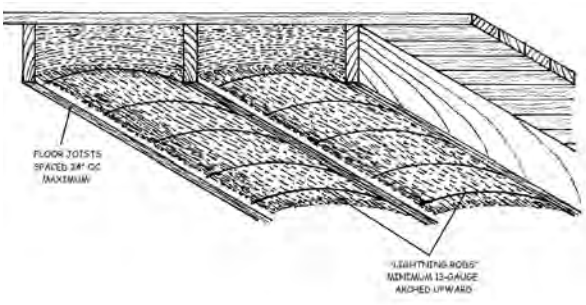


FIG. 39-4: SPRING WIRE SUPPORT RODS

4.2.7(c2) See Fig. 39-4.

4.2.7(c3) On joists >24" on center (OC), spring wire support rods are not allowed.

4.2.7(d) Wire support with anchor points

4.2.7(d1) Wire shall be a minimum of 20-gauge and corrosion-resistant.

4.2.7(d2) For joists ≤24" OC, span cavities in a zig-zag pattern with anchor points spaced a maximum of 18" apart.

4.2.7(d3) For joists ≥25" OC, span cavities in a zig-zag pattern with anchor points spaced a maximum of 12" apart.

- Staple insulation facing to the subfloor.

4.2.7(d4) See Fig. 39-5.

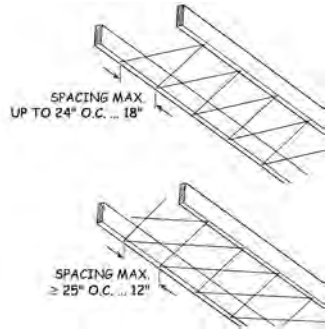


Fig. 39-5: Installation of Wire Support

4.2.7(e) Woven wire or netting support

4.2.7(e1) Anchor woven wire support to the joist every 12".

4.2.7(e2) The support shall not sag more than 1" per 24" of span in any direction.

4.2.7(e3) See Fig. 39-6.

Fig. 39-6: Installation of Woven Wire

4.2.8 Installation of Vapor Retarder

4.2.8(a) Install a Class I or Class II vapor retarder (e.g., ≥6-mil sheet polyethylene) over the earth in the crawlspace with 100% coverage after all work in the crawlspace has been completed (Fig. 39-7).

4.2.8(b) Existing undamaged ground cover is an acceptable alternative to vapor retarder if it is at least 4 mil thick.

4.2.8(c) Repair all plumbing leaks and pooling moisture before installing a vapor retarder.

4.2.8(d) Vapor retarder shall not:

4.2.8(d1) Obstruct any combustion air supply

4.2.8(d2) Interfere with the established drainage

- Interior drainage collection points must be accessible from above and below the ground vapor retarder.

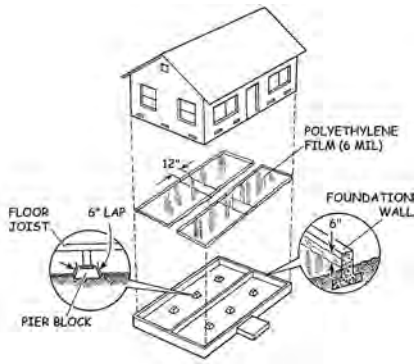


Fig. 39-7: Installation of Vapor Retarder

4.2.8(e) Cover 100% of crawlspace earth with vapor retarder.

4.2.8(f) Overlap joints by 12" using a “reverse” or “upslope lapping” technique.

4.2.8(g) Fasten vapor retarder/ground moisture barrier to the ground with durable fasteners or ballast(s).

4.2.8(h) Extend the vapor retarder 6" up the foundation wall.

4.2.8(h1) Secure the vapor retarder as needed to keep it in place (e.g., with tape).

4.2.8(h2) The vapor retarder shall not touch wood members.

4.2.8(h3) For wall-to-floor connection, install the wall vapor retarder under the ground vapor retarder.

- Secure the vapor retarder in place with durable fasteners or tape a minimum of every 8'.

4.2.8(h4) If tape is used to secure polyethylene, the sheeting must be clean before applying tape, and the tape must adhere to it.

4.2.8(i) Seal seams with a durable sealant that is compatible with the retarder (e.g., tape or adhesive).

4.2.8(j) Care will be taken to prevent punctures during installation

4.2.9 Alternatives to Standard Floor Insulation

4.2.9(a) Basement wall insulation

4.2.9(a1) No ground water leakage shall be present.

4.2.9(a2) Install a continuous air barrier on the warm side of the insulation.

4.2.9(a3) When absorbent insulation materials are installed, the assembly must remain vapor-permeable to the interior in all climate zones.

4.2.9(b) Underfloor insulation where no foundation wall exists

4.2.9(b1) If the insulation will be exposed to rain, snow, etc., do not install it unless the exposure can be corrected within the scope of the weatherization program.

4.2.9(b2) If the insulation will be exposed to wind and animals:

- Insulate with batts or foil-clad foam board (Fig. 39-8)
- Support batts with woven wire or a minimum 70-perm breathable cover

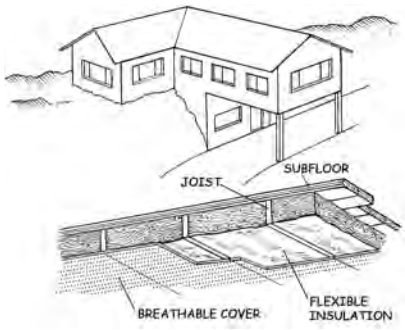


FIG. 39-8: UNDERFLOOR INSULATION WHERE NO FOUNDATION WALL EXISTS

4.2.10 Crawlspace Sign Requirement

4.2.10(a) A durable (10-year life expectancy), and legible sign (minimum 8½" x 11") shall be posted at all accesses to the crawlspace when floor insulation and/or a vapor retarder is installed.

4.2.10(b) Crawlspace sign content

4.2.10(b1) Those entering the crawlspace must be cautioned not to damage the air barrier, ground vapor retarder, insulation, and mechanical components specific to the crawlspace type.

4.2.10(b2) Installer contact information must be included on the sign to address questions or repairs.

4.2.10(b3) Language prohibiting the storage of hazardous/toxic and flammable materials in the crawlspace shall be included on the sign.

4.2.11 Insulation Certificate

4.2.11(a) An insulation certificate (CSD 610 form) shall be completed and signed by the contractor responsible for installing the insulation.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

5.1.2 Before installing this measure, prior approval must be granted from the California Department of Housing and Community Development (HCD), or another authority having jurisdiction.

5.1.3 The bellyboard must be capable of supporting the added weight of insulation and blower pressure.

5.1.4 The undercarriage must be protected from the environment by sheathing or rodent-proof skirting

5.1.5 This measure is not allowed if an enclosed (finished) floor cavity requiring blind fill has a heat-producing device (HPD) that cannot be properly protected and provided with a 3" clearance

5.1.6 Crawlspace ventilation must conform with Department of Housing and Urban Development (HUD) code when floor insulation is installed. If existing ventilation is inadequate/non-conforming, it must be corrected per Section 41 Crawlspace Ventilation.

5.1.7 Before floor insulation is installed, abandon unducted belly-cavity returns, and install a central ducted return in conformance with Appendix B Duct Leakage Testing Protocol.

5.1.8 When required by HUD code, a vapor barrier shall be installed after insulation has been installed.

5.1.9 Approved Installation Methods

5.1.9(a) Rigid or flexible insulation shall not be installed under the bellyboard.

5.1.9(b) Cavity fill

5.1.9(b1) Belly cavity fill through the bellyboard (rodent barrier) is the preferred insulation method.

5.1.9(c) Rim joist injection

5.1.9(c1) Rim joist injection through ends or sides of mobile home is acceptable.

5.1.9(c2) All interior areas not accessible from the outside perimeter shall be accessed through the belly.

5.1.9(d) Flexible (batt) replacement

5.1.9(d1) Damaged and missing flexible insulation shall be replaced with new flexible insulation. Restore or replace the rodent barrier.

5.1.10 Insulation R-Value

5.1.10(a) New insulation shall bring the level up to the “final R-value” required by Table 39-1.

5.1.11 Conditions Requiring a Vapor Retarder

5.1.11(a) A vapor retarder is installed in conjunction with floor insulation when:

5.1.11(a1) Ground water problems exist

5.1.11(a2) Required by the local jurisdiction

5.1.11(a3) Specified by floor insulation type in this standard

5.1.11(b) Installation of a vapor retarder is not required when only ventilation is installed as a stand-alone measure.

5.1.12 Preparation of Crawlspace

5.1.12(a) Where accessible for inspection, ensure the following:

5.1.12(a1) Duct sealing is completed

5.1.12(a2) Gas, water, and electrical lines are secured at least every 4' to a floor joist or framing member

5.1.12(a3) Water line will be located on the warm side of the insulation; if not, the water lines will be insulated appropriately

5.1.12(a4) No water or gas leaks are present

5.1.12(a5) Waste lines are sloped to ¼" per foot

5.1.12(a6) Holes and penetrations in the bottom board and decking are sealed

5.1.12(a7) Bottom board/rodent barrier is sound/strong enough to support insulation

5.1.12(b) Problems will be corrected before floor cavity insulation work begins.

5.1.13 Vapor Retarder Installation Procedure:

5.1.13(a) When installation of a ground cover is required:

5.1.13(a1) Properly install skirting around the entire perimeter

5.1.13(a2) Extend extremities a minimum of 6" up the inside of the existing skirting

5.1.13(a3) Attach vapor barrier to existing skirting with adhesive caulk or mechanical means

5.1.14 Water Pipes and HVAC Ducts

5.1.14(a) Water pipes shall not be isolated from the warm side of the added insulation (See Fig. 39-1).

5.1.14(b) Tag water valves if they are covered by insulation.

5.1.14(c) Installation of water pipe heaters is not allowed.

5.1.15 Cavity Fill Installation Method

5.1.15(a) All areas shall be insulated except those occupied by ducts, plenums, combustion air intakes, or other obstructions.

5.1.15(b) All regulations restricting placement of insulation in cavities containing aluminum wiring shall be observed.

5.1.15(c) Access

5.1.15(c1) Bellyboard penetration is preferred in all cases.

5.1.15(c2) Penetration is required to insulate all interior areas not accessible through the rim joists.

5.1.15(c3) Holes cut for inspection purposes shall also be used for fill tube.

5.1.15(c4) Existing damage holes shall be used for fill tube access when feasible.

5.1.15(c5) Make additional penetrations, as needed, to achieve complete coverage.

5.1.15(c6) Access point spacing

- Space holes to accommodate the directional nozzle or fill tube utilized.
- Maximum insulation travel beyond fill tube or nozzle shall be 2'.

5.1.15(c7) Hole size

- Make holes of sufficient size to properly accommodate the directional nozzle and/or fill tube.

5.1.15(d) Installation

5.1.15(d1) Recommended nozzle and fill tube size: 2" outside diameter, 1½" inside diameter

5.1.15(d2) Flexible fill tube shall be no more than 2' shorter than the length of the cavity being filled.

5.1.15(d3) Directional nozzle shall cover 2’ of cavity depth in each direction.

5.1.15(d4) Installer shall be equipped with a remote-control switch to control the blowing machine.

5.1.15(d5) Insulate each cavity to specified R-value and density.

5.1.15(d6) The number of bags installed will be confirmed and will match the number required on the manufacturer's coverage chart.

5.1.15(e) Insulation hole repair

5.1.15(e1) Repair all bellyboard holes with material equivalent or superior to the existing bellyboard.

5.1.15(e2) Securely attach all bellyboard material to create a complete and permanent seal.

5.1.16 Rim Joist Installation Method

5.1.16(a) Rim joist penetration is an acceptable method when joist size and condition allow for safe and proper installation.

5.1.16(b) This method is used to insulate joist cavities or portions of cavities which have unobstructed access from the outside perimeter.

5.1.16(c) A combination of cavity fill (belly) and joist penetrations shall be used as needed to achieve cavity coverage.

5.1.16(d) Access

5.1.16(d1) Penetration points shall be those that provide the most accessibility.

5.1.16(d2) Remove bottom wall to expose the rim joist.

5.1.16(d3) When necessary, unfasten and carefully pull back exterior siding.

5.1.16(d4) Rim joist access shall be considered not feasible if it will result in visible damage to the siding.

5.1.16(e) Access point spacing

5.1.16(e1) End and side joists

- Drill one access point for each floor joist cavity.
- Locate access points as close as possible to the vertical center of the rim joist to minimize structural weakening.
- Exercise care in access point placement to avoid damage to plumbing and electrical lines attached or adjacent to the rim joist.

5.1.16(e2) Side rim joists

- Access adjacent joist cavities alternately from opposite sides of the mobile home, as feasible, to minimize the number of holes in each rim joist.
- Rim joist holes shall not exceed the size limitations in Table 39-2:

5.1.16(e3) Recommended nozzle and fill tube size is 2" outside diameter, 1½" minimum inside diameter.

5.1.16(e4) The fill tube shall be no more than 2' shorter than the length of the cavity being filled.

TABLE 39-2: RIM JOIST HOLE SIZE LIMITATIONS

Joist Size	Maximum Hole Size
2" x 8"	2½"
2" x 6"	2"
2" x 4"	Not allowed

5.1.16(e5) The installer shall be equipped with a remote-control switch to control the blowing machine

5.1.16(e6) Insulation access point repair

- Install solid wood plugs in all fill holes.
- Secure plugs with exterior-rated glue or sealant.

5.1.17 Flexible Batt Installation Method

5.1.17(a) Access

5.1.17(a1) Ensure complete accessibility of floor cavity.

5.1.17(a2) Remove damaged insulation and all remnants of bottom board.

5.1.17(a3) Clean floor cavities.

5.1.17(b) Installation

5.1.17(b1) Exposed HVAC ducts shall be protected with insulation and rodent barrier.

5.1.17(b2) If insulation has facing, install facing in contact with the heated side.

5.1.17(b3) Install insulation in contact with subfloor.

5.1.17(b4) Support insulation (e.g., metal insulation supports) to maintain a permanent contact with subfloor.

5.1.17(b5) Notch insulation around all wires, pipes, and blocks.

5.1.17(b6) Insulate ducts and water lines for climate conditions.

5.1.17(b7) Locate water lines above the warm side of the insulation (toward the conditioned space), when feasible.

5.1.17(b8) Insulation will not have gaps, voids, or be compressed.

5.1.17(c) Air Barrier

5.1.17(c1) A rigid air barrier will be installed in contact with the bottom of the joists, when feasible.

5.1.17(c2) Rigid air barrier will be fastened as to not sag, bend, or fall off.

5.1.17(c3) Seams, holes, and joints in the air barrier will be sealed.

5.1.17(c4) In cases where HVAC ducts hang below the level of the rigid air barrier and insulation, the ducts will be insulated and air barrier provided that is sealed to the rigid air barrier.

5.1.18 Rodent Barrier Repair

5.1.18(a) After undercarriage insulation is installed the rodent barrier shall be sealed, repaired, or replaced.

5.1.18(b) Repair of flexible rodent barrier

5.1.18(b1) Secure and seal all repair materials by means of self-adhesive backing, caulk, or other suitable adhesive sealant.

5.1.18(b2) Patches shall be additionally secured mechanically with one or more of the following as needed to ensure permanence:

- Outward clinch (“stitch”) staples or equivalent spaced to permanently and securely attach the patch directly to the existing bellyboard
- Fasteners penetrating the wooden joists a minimum of ½" and spaced a maximum of 4" OC
- Wooden strips attached with screws into floor joists, or wedged above adjacent girders, or otherwise permanently secured

5.1.18(b3) Place Underwriters Laboratories (UL) 181B-FX butyl tape or other sealant around the perimeter, as needed, to ensure a complete and permanent seal.

5.1.18(c) Repair of rigid rodent barrier

5.1.18(c1) Seal repair material with suitable caulk and secured mechanically.

5.1.18(c2) Approved mechanical attachments include:

- Fasteners that penetrate the wooden joists a minimum of ¾" and are spaced a maximum of 6" OC
- Wooden strip supports that span beyond the patch and secure mechanically into the framework above
- Wedging of patching material between the existing bellyboard and the metal framing of the undercarriage
- Fasteners that penetrate only the existing bellyboard, for small patches in high density material
- A combination of methods which will provide a stable, permanent repair

5.1.18(d) Penetrations in the belly board patch (ducts and pipes)

5.1.18(d1) Seal penetrations with UL 181B-FX butyl tape or equivalent.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit in a multi-family building will be served, this measure is not feasible.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.3 Installation (e.g., installation of insulation within the same thermal boundary as dwelling units) is allowed when justified by an energy audit for a whole-building project, per Appendix D Energy Audit/Priority List Protocol.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 To assess for this measure as part of a DOE work scope, it is required to complete the CSD 710 Energy Audit/Priority List Checklist.

7.1.1 (a) The form will determine if the measure will be installed in the Audit path or the Priority List (PL) path.

7.1.1 (b) When assessing this measure for the Audit path, measure feasibility will be decided by the energy audit with a Measure savings-to-investment ratio (SIR) and Dwelling SIR.

7.1.1 (b1) When the measure is feasible based on the audit, and the measure is categorized as a “Major” measure (i.e., Infiltration Reduction, Duct Sealing, Ceiling Insulation, Floor Insulation, and Wall Insulation), the measure shall be installed or the dwelling must be deferred.

7.1.1 (c) When assessing for the measure in the PL path, the feasibility will be based on building type and characteristics.

7.1.1 (c1) PL measures are classified as Mandatory or Optional based on building type.

- Mandatory measures on the PL path must be installed when feasible, or the dwelling shall be deferred.
- Optional measures may be installed only after all feasible Mandatory PL measures have been installed.

7.1.1 (c2) This PL measure applies to all dwelling types.

7.1.1 (d) When this measure is fully leveraged or co-funded with LIHEAP, DOE-specific assessment and installation policies will apply. For additional details, refer to Appendix D Energy Audit/Priority List Protocol.

7.1.2 If a client refuses a feasible Audit path Major measure, Mandatory Priority List path, or Health & Safety measure, the entire dwelling shall be deferred.

7.1.3 The R-value of added insulation shall be:

7.1.3 (a) A minimum R-value set by Table 39-1

7.1.3 (b) A maximum R-value as defined by energy audit

7.1.4 Crawlspace ventilation will only be installed in conjunction with floor insulation per Section 41 Crawlspace Ventilation.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2 (a) Excerpted from 2017 SWS 2.0403.2:

7.2.2 (a1) An air barrier and ground moisture barrier covering the exposed crawlspace floor will be installed and sealed to the wall’s air and moisture barrier in accordance with ASTM E1643 and manufacturer’s recommendations.

7.2.2 (b) Excerpted from 2017 SWS 4.1301.5:

7.2.2 (b1) Cantilevered floor—Batt installation

- Air barrier will be installed between joists and sealed
- Air barrier will be placed to the most interior edge of the top plate of the wall below
- Air barrier will be insulated between joist from top plate of the wall below to subfloor above
- Cantilevered subfloor will be insulated in complete contact with the floor without gaps, voids, compressions, misalignments, or wind intrusions
- Exterior soffit material will be installed and sealed

7.2.2(c) Excerpted from 2017 SWS 4.1301.6:

7.2.2(c1) Pier Construction Subfloor Insulation—Batt Installation Loose Fill with Rigid Barrier

- A rigid air barrier will be mechanically fastened to underside of floor assembly to protect insulation
- Seams and penetrations will be sealed

7.2.3 Mobile Home

7.2.3(a) Excerpted from 2017 SWS 4.1303.2:

7.2.3(a1) A rigid air barrier will be installed in contact with the bottom of the joists, when feasible

7.2.3(a2) Rigid air barrier will be fastened as to not sag, bend, or fall off

7.2.3(a3) Seams, holes, and joints in the air barrier will be sealed

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Combustion appliance safety testing must be performed upon completion of all measures that affect air tightness of home, per Appendix A Combustion Appliance Safety Protocol.

8.1.2 The required clearance zones for HPDs and crawlspace venting shall be unobstructed by insulation or vapor retarder.

8.1.3 Completed floor insulation sections shall be confirmed to have an even level of insulation at the prescribed R-value.

8.1.4 There shall be no voids, gaps, or separations from the sub-floor.

8.1.5 Installed insulation shall not be compressed more than 10% to negatively impact the efficiency of the insulation R-value.

8.1.6 The number of bags of insulation installed shall be confirmed and must match the number required on the manufacturer's coverage chart.

8.2. Client Education

8.2.1 A copy of the completed CSD 610 Insulation Certificate must be provided to the client.

8.2.2 Unless virgin resin or reinforced material ≥10 mil was installed, the client shall be advised that the vapor retarder is biodegradable, will have a life span much shorter than the home (approximately 5 years), and will need to be replaced to remain effective.

8.3. Clean-Up and Disposal Requirements

8.3.1 Upon completion, the residence shall be returned to its original condition and left free of job-related dust and debris indoors and outdoors.

8.3.1(a) All areas between indoor work areas and the home entrance shall be vacuumed.

8.3.1(b) The area between the home entrance/access and the insulation truck shall be swept or vacuumed.

8.3.2 A high-efficiency particulate air filter vacuum shall be used for all vacuuming.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP:

9.1.1(a) Loose and batt types installed in fully closed, air-tight cavities—20 years

9.1.1(b) Rigid insulation—20 years

9.1.1(c) All other types including loose fill and batt not installed in fully closed, air-tight cavities—Not applicable to this measure

9.1.2 DOE:

9.1.2(a) Loose and batt types installed in fully closed, air-tight cavities—30 years

9.1.2(b) Rigid insulation—30 years

9.1.2(c) All other types including loose fill and batt not installed in fully closed, air-tight cavities—20 years

9.2 All insulation materials shall be approved for sale in California and certified to comply with the material specifications in the California Code of Regulations, Title 24, Part 12, Chapters 12–13, article 3, “Standards for Insulating Material.”

9.3 Insulation material used in mobile homes will be non-corrosive and of minimal water absorbency.

9.4 Mineral Fiber

9.4.1 Batts shall conform to American Society of Testing and Materials (ASTM) C665 for material and facing (including flame spread and smoke density).

9.4.2 Loose fill shall conform to ASTM C764 and ASTM E84.

9.5 Cellulose loose fill shall be listed in the Department of Consumer Affairs’ “Directory of Certified Insulation Materials.”

9.6 Rigid insulation shall be:

9.6.1 Pre-formed polyisocyanurate board, foil-faced on both sides, that conforms with Federal Standard (FS) HH-1-1972/1 or

9.6.2 High-density fiberglass board that conforms with ASTM C726

9.7 Vapor retarder shall be:

9.7.1 Class I vapor retarder with a perm rating of ≤0.1

9.7.1(a) Can be ≥6 mil sheet polyethylene or unperforated aluminum foil (e.g., foil/scrim/kraft)

9.7.2 Class II vapor retarder with a perm rating of 0.1–1.0 (semi-impermeable)

9.7.2(a) Can be sheet polyethylene

9.7.3 In accordance with tear- and puncture-resistance standard ASTM E1745

9.8 Insulation cover shall be a minimum 70-perm breathable cover.

9.9 Supports and Anchors

9.9.1 All attachment materials shall be corrosion resistant have a minimum expected service life of 10 years.

9.9.2 Staples shall be ≥18-gauge, minimum ¼" crown for lath or ⅜" crown for other supports, and provide ≥⅝" joist penetration.

9.9.3 Nails shall be galvanized with ≥⅝" joist penetration.

9.9.4 Wire supports shall be minimum 20-gauge galvanized wire.

9.9.5 Woven wire shall be galvanized wire.

9.9.6 Polypropylene netting shall have ≥75-lb. breaking strength.

9.9.7 Spring Wire Support Rods (“Lightning Rods”) for Flexible Insulation Types

9.9.7(a) Spring steel wire with chisel points (lightning rods, wirestays)

9.9.7(b) Minimum 13-gauge

9.10 Foundation vents shall conform with Section 41 Crawlspace Ventilation.

9.10.1 New or modified vents shall be covered with ¼" weave galvanized mesh.

9.11 Access Cover Insulation

9.11.1 Refer to Table 39-1.

9.12 Crawlspace Access Door/Cover

9.12.1 Refer to Section 32 Infiltration Reduction, Material Specifications.

10. WARRANTY

10.1 Manufacturer—Limited lifetime

10.2 Contractor—1 year

40. Attic Ventilation

Table of Contents

Attic Ventilation

1. MEASURE OBJECTIVES

1.1 In warm temperatures, attic ventilation expels solar-heated hot air to lessen the cooling load. In cool temperatures, attic ventilation vents out moisture build-up.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 The existing mesh is missing or has tears or gaps

2.2. Install

2.2.1 No attic ventilation exists, or the existing ventilation is inadequate or

2.2.2 When replacing smaller weave mesh with larger weave mesh for additional net free ventilation area (NFVA)

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1. Do Not Repair

3.1.1 Repair of the mesh would make the NFVA inadequate

3.2. Do Not Install

3.2.1 The existing attic ventilation is adequate and functioning properly

3.2.2 The attic is inaccessible, or there is inadequate clearance per Section 1 General Installation Guidelines, Attic and Crawlspace Accessibility

3.2.3 The exhaust system venting that terminates in the attic, unless it can be vented outdoors under Section 1 General Installation Guidelines, Limited Home Repair

3.2.4 The roof is unsound or unsafe, roofing material is likely to be damaged, or roof leaks exist

3.2.5 There are no suitable locations to install attic venting. For example:

3.2.5(a) Tiled, metal, or wood shingles/shakes

3.2.5(b) A hip roof that does not have an overhang, soffit, or accessible frieze blocks

3.2.5(c) A roof in poor condition, e.g., more than three layers of roofing exist

3.2.5(d) A flat or low-slope built-up roof

3.2.6 Installation would violate the Appendix E Health and Safety Requirements

3.2.7 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Attic ventilation may be installed as a stand-alone measure or in conjunction with ceiling insulation.

4.1.2 Audited Measures

4.1.2(a) When this measure will be installed under the Low Income Home Energy Assistance Program (LIHEAP) and an energy audit is performed, if the measure will be fully leveraged or co-funded, it must comply with Appendix D Energy Audit/Priority List Protocol.

4.1.2(b) When this measure is paid for by LIHEAP, or is co-funded with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply.

4.1.3 The presence of an effective air barrier and thermal boundary between the attic and the living space must be verified by the assessor.

4.1.4 Replacing smaller weave mesh vents with larger weave mesh screen is allowed if additional NFVA is required.

4.1.5 Additional vents or larger vents can be added if screen size is smaller than designated.

4.1.6 Venting used for combustion ventilation air (CVA) must remain unobstructed.

4.1.7 Knob-and-tube (K&T) wiring: When K&T wiring is present in the attic, follow the requirements in Section 1 General Installation Guidelines, Knob & Tube (K&T) Wiring Guidelines.

4.1.8 Vent Composition

4.1.8(a) Screens must be clean, and vents must be free of insulation and other obstructions.

4.1.8(b) On new and replaced vents, ⅛"–¼" mesh screen is required.

4.1.9 Amount of Attic Ventilation

4.1.9(a) The required NFVA shall conform with local code.

4.1.9(b) The existing attic NFVA shall be calculated using the NFVA tables, reduction factors, and NFVA calculations for specific vent types in the following sections.

4.1.9(c) Total NFVA of the openings:

4.1.9(c1) 1 sq. ft. of NFVA is required per 150 sq. ft. of ceiling area with cross-ventilation (as defined in Attic Vent Placement—All Vents) (Table 40-1).

4.1.9(c2) 1 sq. ft. of NFVA per 300 sq. ft. of ceiling area is allowed when one or more of the following conditions are met with cross-ventilation (Table 40-2):

- Condition 1: Upper venting comprises 40%–50% of attic venting, with upper vents located within 3' of the ridge or the highest point of the space. The balance of the venting shall be lower venting.
- Condition 2: In climate zones 14 and 16, when a Class I or II vapor retarder is installed on the winter warm side.

4.1.9(c3) Local code requirements apply if more stringent.

TABLE 40-1: SQ. FT. OF NFVA FOR A 1:150 RATIO

Area Length \ Area Width	10'	12'	14'	16'	18'	20'	22'	24'	26'	28'	30'	32'	34'	36'	38'	40'
10'	0.7	0.8	0.9	1.1	1.2	1.3	1.5	1.6	1.7	1.9	2.0	2.1	2.3	2.4	2.5	2.7
12'	0.8	1.0	1.1	1.3	1.4	1.6	1.8	1.9	2.1	2.2	2.4	2.6	2.7	2.9	3.0	3.2
14'	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.5	3.7
16'	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.1	4.3
18'	1.2	1.4	1.7	1.9	2.2	2.4	2.6	2.9	3.1	3.4	3.6	3.8	4.1	4.3	4.6	4.8
20'	1.3	1.6	1.9	2.1	2.4	2.7	2.9	3.2	3.5	3.7	4.0	4.3	4.5	4.8	5.1	5.3
22'	1.5	1.8	2.1	2.3	2.6	2.9	3.2	3.5	3.8	4.1	4.4	4.7	5.0	5.3	5.6	5.9
24'	1.6	1.9	2.2	2.6	2.9	3.2	3.5	3.8	4.2	4.5	4.8	5.1	5.4	5.8	6.1	6.4
26'	1.7	2.1	2.4	2.8	3.1	3.5	3.8	4.2	4.5	4.9	5.2	5.5	5.9	6.2	6.6	6.9
28'	1.9	2.2	2.6	3.0	3.4	3.7	4.1	4.5	4.9	5.2	5.6	6.0	6.3	6.7	7.1	7.5
30'	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6	8.0
32'	2.1	2.6	3.0	3.4	3.8	4.3	4.7	5.1	5.5	6.0	6.4	6.8	7.3	7.7	8.1	8.5
34'	2.3	2.7	3.2	3.6	4.1	4.5	5.0	5.4	5.9	6.3	6.8	7.3	7.7	8.2	8.6	9.1
36'	2.4	2.9	3.4	3.8	4.3	4.8	5.3	5.8	6.2	6.7	7.2	7.7	8.2	8.6	9.1	9.6
38'	2.5	3.0	3.5	4.1	4.6	5.1	5.6	6.1	6.6	7.1	7.6	8.1	8.6	9.1	9.6	10.1
40'	2.7	3.2	3.7	4.3	4.8	5.3	5.9	6.4	6.9	7.5	8.0	8.5	9.1	9.6	10.1	10.7

TABLE 40-2: SQ. FT. OF NFVA FOR A 1:300 RATIO

Area Length \ Area Width	10'	12'	14'	16'	18'	20'	22'	24'	26'	28'	30'	32'	34'	36'	38'	40'
10'	0.3	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.9	0.9	1.0	1.1	1.1	1.2	1.3	1.3
12'	0.4	0.5	0.6	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.2	1.3	1.4	1.4	1.5	1.6
14'	0.5	0.6	0.7	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9
16'	0.5	0.6	0.7	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1
18'	0.6	0.7	0.8	1.0	1.1	1.2	1.3	1.4	1.6	1.7	1.8	1.9	2.0	2.2	2.3	2.4
20'	0.7	0.8	0.9	1.1	1.2	1.3	1.5	1.6	1.7	1.9	2.0	2.1	2.3	2.4	2.5	2.7
22'	0.7	0.9	1.0	1.2	1.3	1.5	1.6	1.8	1.9	2.1	2.2	2.3	2.5	2.6	2.8	2.9
24'	0.8	1.0	1.1	1.3	1.4	1.6	1.8	1.9	2.1	2.2	2.4	2.6	2.7	2.9	3.0	3.2
26'	0.9	1.0	1.2	1.4	1.6	1.7	1.9	2.1	2.3	2.4	2.6	2.8	2.9	3.1	3.3	3.5
28'	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.5	3.7
30'	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
32'	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.1	4.3
34'	1.1	1.4	1.6	1.8	2.0	2.3	2.5	2.7	2.9	3.2	3.4	3.6	3.9	4.1	4.3	4.5
36'	1.2	1.4	1.7	1.9	2.2	2.4	2.6	2.9	3.1	3.4	3.6	3.8	4.1	4.3	4.6	4.8
38'	1.3	1.5	1.8	2.0	2.3	2.5	2.8	3.0	3.3	3.5	3.8	4.1	4.3	4.6	4.8	5.1
40'	1.3	1.6	1.9	2.1	2.4	2.7	2.9	3.2	3.5	3.7	4.0	4.3	4.5	4.8	5.1	5.3

4.1.10 Reduction Factors

4.1.10(a) When the vent manufacturer does not provide NFVA, use Table 40-3 and the area of the vent opening to determine NFVA.

4.1.10(a1) Example: An eave vent has a ¼" screen (no louvers) with a vent opening (excluding the frame) that is 2½" x 17".

- The screened opening is 2½" x 17" = 42.5 sq. in.
- Table 40-3 shows the reduction factor for a vent with ¼" screen and no louvers is 90%.
- 42.5 sq. in. x 0.90 = 38.25 sq. in.
- Divide sq. in. by 144 to calculate sq. ft.: 38.25/144 = 0.27 sq. ft. of NFVA.

TABLE 40-3: SCREEN AND LOUVER NFVA REDUCTION FACTORS

¼" Screen, No Louvers	⅛" Screen, No Louvers	1/16" Screen, No Louvers	Metal Louvers with or without ¼" or ⅛" Screen	Wood Louvers with or without ¼" or ⅛" Screen
0.90 (90%)	0.75 (75%)	0.50 (50%)	0.75 (75%)	0.25 (25%)

4.2. Vent Tables

4.2.1 Table 40-4 through Table 40-22 can be used to determine the NFVA provided by a particular type and size of vent. The NFVA shown includes the reduction factor and is given in sq. ft.

4.2.2 When vent measurements are between the sizes listed, calculate manually.

4.2.3 Rectangular Gable Vents

4.2.3(a) Example: (Fig. 40-1, Table 40-4, and Table 40-5)

4.2.3(a1) If a 16" x 14" rectangular gable vent is to be installed, first find the 16" height in the left column of Table 40-4. Move across that row to the column representing the 14" width (shown in the top row). At the intersection of the 16" height row and 14" width column, find “1.17.”

- One vent provides 1.17 sq. ft. of NFVA.

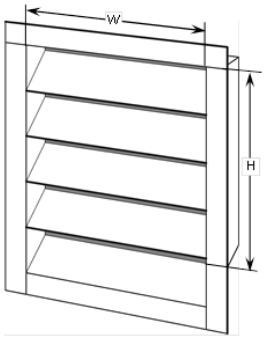


FIG. 40-1: RECTANGULAR GABLE VENT

TABLE 40-4: SQ. FT. OF NFVA FOR RECTANGULAR GABLE VENTS—¼" OR ⅛" SCREEN WITH METAL LOUVERS (REDUCTION FACTOR = 0.75)

		Width									
		11"	12"	14"	16"	18"	20"	22"	24"	30"	36"
Height	8"	0.46	0.50	0.58	0.67	0.75	0.83	0.92	1.00	1.25	1.50
	10"	0.57	0.63	0.73	0.83	0.94	1.04	1.15	1.25	1.56	1.88
	12"	0.69	0.75	0.88	1.00	1.13	1.25	1.38	1.50	1.88	2.25
	14"	0.80	0.88	1.02	1.17	1.31	1.46	1.60	1.75	2.19	2.63
	16"	0.92	1.00	1.17	1.33	1.50	1.67	1.83	2.00	2.50	3.00
	18"	1.03	1.13	1.31	1.50	1.69	1.88	2.06	2.25	2.81	3.38
	20"	1.15	1.25	1.46	1.67	1.88	2.08	2.29	2.50	3.13	3.75
	22"	1.26	1.38	1.60	1.83	2.06	2.29	2.52	2.75	3.44	4.13
	24"	1.38	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.75	4.50
	26"	1.49	1.63	1.90	2.17	2.44	2.71	2.98	3.25	4.06	4.88
	28"	1.60	1.75	2.04	2.33	2.63	2.92	3.21	3.50	4.38	5.25
	30"	1.72	1.88	2.19	2.50	2.81	3.13	3.44	3.75	4.69	5.63
	32"	1.83	2.00	2.33	2.67	3.00	3.33	3.67	4.00	5.00	6.00
	34"	1.95	2.13	2.48	2.83	3.19	3.54	3.90	4.25	5.31	6.38
	36"	2.06	2.25	2.63	3.00	3.38	3.75	4.13	4.50	5.63	6.75

TABLE 40-5: SQ. FT. OF NFVA FOR RECTANGULAR GABLE VENTS—¼" OR ⅛" SCREEN WITH WOOD LOUVERS (REDUCTION FACTOR = 0.25)

		Width								
		12"	14"	16"	18"	20"	22"	24"	30"	36"
Height	8"	0.17	0.19	0.22	0.25	0.28	0.31	0.33	0.42	0.50
	10"	0.21	0.24	0.28	0.31	0.35	0.38	0.42	0.52	0.63
	12"	0.25	0.29	0.33	0.38	0.42	0.46	0.50	0.63	0.75
	14"	0.29	0.34	0.39	0.44	0.49	0.53	0.58	0.73	0.88
	16"	0.33	0.39	0.44	0.50	0.56	0.61	0.67	0.83	1.00
	18"	0.38	0.44	0.50	0.56	0.63	0.69	0.75	0.94	1.13
	20"	0.42	0.49	0.56	0.63	0.69	0.76	0.83	1.04	1.25
	22"	0.46	0.53	0.61	0.69	0.76	0.84	0.92	1.15	1.38
	24"	0.50	0.58	0.67	0.75	0.83	0.92	1.00	1.25	1.50
	26"	0.54	0.63	0.72	0.81	0.90	0.99	1.08	1.35	1.63
	28"	0.58	0.68	0.78	0.88	0.97	1.07	1.17	1.46	1.75
	30"	0.63	0.73	0.83	0.94	1.04	1.15	1.25	1.56	1.88
	32"	0.67	0.78	0.89	1.00	1.11	1.22	1.33	1.67	2.00
	34"	0.71	0.83	0.94	1.06	1.18	1.30	1.42	1.77	2.13
	36"	0.75	0.88	1.00	1.13	1.25	1.38	1.50	1.88	2.25

4.2.4 Triangular Gable Vents

4.2.4(a) (Fig. 40-2, Table 40-6, and Table 40-7)

4.2.4(b) The area of a triangle is: Width x Height / 2.

4.2.4(c) Example: A triangle vent has a ¼" screen (no louvers) with a vent opening (excluding the frame) that is 40" x 20".

- The screened opening is 40" x 20" / 2 = 400 sq. in.
- Table 40-3 shows the reduction factor for a vent with ¼" screen and no louvers is 75%.
- 400 sq. in. x 0.75 = 300 sq. in.
- Divide sq. in. by 144 to calculate sq. ft.: 300/144 = 2.08 sq. ft. of NFVA.

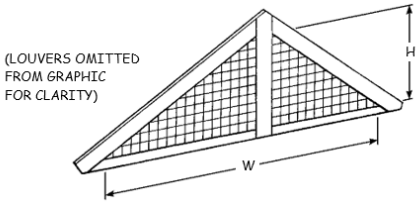


FIG. 40-2: TRIANGULAR GABLE VENT

TABLE 40-6: SQ. FT. OF NFVA FOR TRIANGULAR GABLE VENTS—¼" OR ⅛" SCREEN WITH METAL LOUVERS (REDUCTION FACTOR = 0.75)

Height \ Width	24"	30"	36"	42"	48"	54"	60"	72"
10"	0.63	0.78	0.94	1.09	1.25	1.41	1.56	1.88
12"	0.75	0.94	1.13	1.31	1.50	1.69	1.88	2.25
14"	0.88	1.09	1.31	1.53	1.75	1.97	2.19	2.63
16"	1.00	1.25	1.50	1.75	2.00	2.25	2.50	3.00
18"	1.13	1.41	1.69	1.97	2.25	2.53	2.81	3.38
20"	1.25	1.56	1.88	2.19	2.50	2.81	3.13	3.75
22"	1.38	1.72	2.06	2.41	2.75	3.09	3.44	4.13
24"	1.50	1.88	2.25	2.63	3.00	3.38	3.75	4.50
26"	1.63	2.03	2.44	2.84	3.25	3.66	4.06	4.88
28"	1.75	2.19	2.63	3.06	3.50	3.94	4.38	5.25
30"	1.88	2.34	2.81	3.28	3.75	4.22	4.69	5.63
32"	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00
34"	2.13	2.66	3.19	3.72	4.25	4.78	5.31	6.38
36"	2.25	2.81	3.38	3.94	4.50	5.06	5.63	6.75

TABLE 40-7: SQ. FT. OF NFVA FOR TRIANGULAR GABLE VENTS—¼" OR ⅛" SCREEN WITH WOOD LOUVERS (REDUCTION FACTOR = 0.25)

Height \ Width	24"	30"	36"	42"	48"	54"	60"	72"
10"	0.21	0.26	0.31	0.36	0.42	0.47	0.52	0.63
12"	0.25	0.31	0.38	0.44	0.50	0.56	0.63	0.75
14"	0.29	0.36	0.44	0.51	0.58	0.66	0.73	0.88
16"	0.33	0.42	0.50	0.58	0.67	0.75	0.83	1.00
18"	0.38	0.47	0.56	0.66	0.75	0.84	0.94	1.13
20"	0.42	0.52	0.63	0.73	0.83	0.94	1.04	1.25
22"	0.46	0.57	0.69	0.80	0.92	1.03	1.15	1.38
24"	0.50	0.63	0.75	0.88	1.00	1.13	1.25	1.50
26"	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.63
28"	0.58	0.73	0.88	1.02	1.17	1.31	1.46	1.75
30"	0.63	0.78	0.94	1.09	1.25	1.41	1.56	1.88
32"	0.67	0.83	1.00	1.17	1.33	1.50	1.67	2.00
34"	0.71	0.89	1.06	1.24	1.42	1.59	1.77	2.13
36"	0.75	0.94	1.13	1.31	1.50	1.69	1.88	2.25

4.2.5 Turbine Vents

4.2.5(a) Several styles of turbine vents exist (Fig. 40-3), each with different NFVA specifications. Use Table 40-8 only when the manufacturer's NFVA specifications are not available.

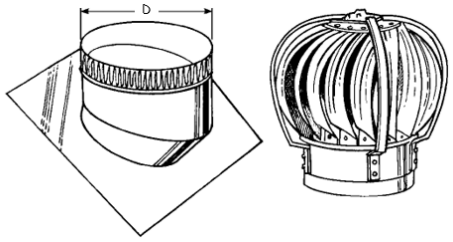


FIG. 40-3: TURBINE VENT

TABLE 40-8: SQ. FT. OF NFVA FOR TURBINE VENTS

# of 12" Turbines	1		2		3		4		5	
# of 14" Turbines		1		2		3		4		5
Sq. Ft. of NFVA Provided	0.79	1.10	1.60	2.20	2.40	3.30	3.20	4.40	4.00	5.50

4.2.6 Round Vents (Bird Holes)

4.2.6(a) (Table 40-9 and Table 40-10)

TABLE 40-9: SQ. FT. OF NFVA FOR BIRD HOLES—¼" SCREEN, NO LOUVERS (REDUCTION FACTOR = 0.90)

	Diameter						
	1.5"	1.75"	2"	2.25"	2.5"	2.75"	3"
Sq. Ft. of NFVA Provided by One Vent	0.0110	0.0150	0.0196	0.0248	0.0307	0.0371	0.0442
# of Vents Needed for 1 Sq. Ft. NFVA	91	67	51	40	33	27	23

TABLE 40-10: SQ. FT. OF NFVA FOR BIRD HOLES—⅛" SCREEN, NO LOUVERS (REDUCTION FACTOR = 0.75)

	Diameter						
	1.5"	1.75"	2"	2.25"	2.5"	2.75"	3"
Sq. Ft. of NFVA Provided by One Vent	0.0092	0.0125	0.0164	0.0207	0.0256	0.0309	0.0368
# of Vents Needed for 1 Sq. Ft. NFVA	109	80	61	48	39	32	27

4.2.7 Round Vents with Louvers

4.2.7(a) Many styles of round vents (Fig. 40-4) exist, each with different NFVA specifications. Use Table 40-11 only when the manufacturer's NFVA specifications are not available.

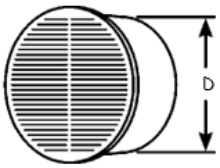


FIG. 40-4: ROUND VENT WITH LOUVER

TABLE 40-11: SQ. FT. OF NFVA FOR LOUVER BIRD HOLE VENTS

	Diameter								
	1"	1.5"	2"	2.5"	3"	4"	5"	6"	8"
Sq. Ft. of NFVA Provided by One Vent	0.0019	0.0043	0.0076	0.0119	0.0172	0.0305	0.0477	0.0687	0.1222
# of Vents Needed for 1 Sq. Ft. NFVA	524	233	131	84	58	33	21	15	8

4.2.8 Eave Vents

4.2.8(a) (Fig. 40-5, Table 40-12, and Table 40-13)

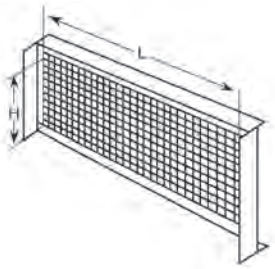


FIG. 40-5: EAVE VENT

TABLE 40-12: SQ. FT. OF NFVA FOR EAVE VENTS—¼" SCREEN, NO LOUVERS (REDUCTION FACTOR = 0.90)

		Length								
		10"	12"	13"	14"	14.5"	16"	18"	21"	22.5"
Height	3"	0.19	0.23	0.24	0.26	0.27	0.30	0.34	0.39	0.42
	3.5"	0.22	0.26	0.28	0.31	0.32	0.35	0.39	0.46	0.49
	4"	0.25	0.30	0.33	0.35	0.36	0.40	0.45	0.53	0.56
	4.5"	0.28	0.34	0.37	0.39	0.41	0.45	0.51	0.59	0.63
	5"	0.31	0.38	0.41	0.44	0.45	0.50	0.56	0.66	0.70
	5.5"	0.34	0.41	0.45	0.48	0.50	0.55	0.62	0.72	0.77

TABLE 40-13: SQ. FT. OF NFVA FOR EAVE VENTS—⅛" SCREEN, NO LOUVERS (REDUCTION FACTOR = 0.75)

		Length								
		10"	12"	13"	14"	14.5"	16"	18"	21"	22.5"
Height	3"	0.16	0.19	0.20	0.22	0.23	0.25	0.28	0.33	0.35
	3.5"	0.18	0.22	0.24	0.26	0.26	0.29	0.33	0.38	0.41
	4"	0.21	0.25	0.27	0.29	0.30	0.33	0.38	0.44	0.47
	4.5"	0.23	0.28	0.30	0.33	0.34	0.38	0.42	0.49	0.53
	5"	0.26	0.31	0.34	0.36	0.38	0.42	0.47	0.55	0.59
	5.5"	0.29	0.34	0.37	0.40	0.42	0.46	0.52	0.60	0.64

4.2.9 Soffit Vents

4.2.9(a) See Fig. 40-6 and Table 40-14.

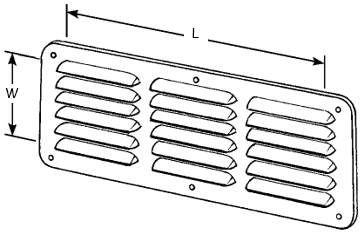


FIG. 40-6: SOFFIT VENT

TABLE 40-14: SQ. FT. OF NFVA FOR SOFFIT VENTS—1/4" OR 1/8" SCREEN WITH METAL LOUVERS (REDUCTION FACTOR = 0.75)

		Length								
		10"	12"	14"	15"	16"	18"	20"	22"	24"
Height	2"	0.10	0.13	0.15	0.16	0.17	0.19	0.21	0.23	0.25
	3"	0.16	0.19	0.22	0.23	0.25	0.28	0.31	0.34	0.38
	3.5"	0.18	0.22	0.26	0.27	0.29	0.33	0.36	0.40	0.44
	4"	0.21	0.25	0.29	0.31	0.33	0.38	0.42	0.46	0.50
	4.5"	0.23	0.28	0.33	0.35	0.38	0.42	0.47	0.52	0.56
	5"	0.26	0.31	0.36	0.39	0.42	0.47	0.52	0.57	0.63
	6"	0.31	0.38	0.44	0.47	0.50	0.56	0.63	0.69	0.75
	8"	0.42	0.50	0.58	0.63	0.67	0.75	0.83	0.92	1.00
	10"	0.52	0.63	0.73	0.78	0.83	0.94	1.04	1.15	1.25

4.2.10 Mushroom Vents

4.2.10(a) (Fig. 40-7, Table 40-15, and Table 40-16)

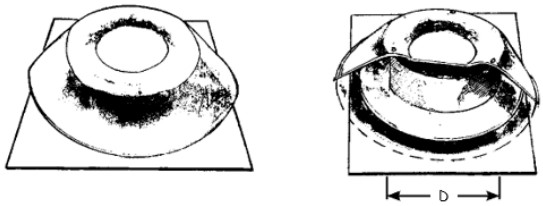


FIG. 40-7: MUSHROOM VENT

TABLE 40-15: SQ. FT. OF NFVA FOR MUSHROOM VENTS— 1/4" SCREEN (REDUCTION FACTOR = 0.90)

	Diameter									
	6"	7"	8"	9"	10"	11"	12"	13"	14"	15"
Sq. Ft. of NFVA	0.18	0.24	0.31	0.40	0.49	0.59	0.71	0.83	0.96	1.10

TABLE 40-16: SQ. FT. OF NFVA FOR MUSHROOM VENTS— 1/8" SCREEN (REDUCTION FACTOR = 0.75)

	Diameter									
	6"	7"	8"	9"	10"	11"	12"	13"	14"	15"
Sq. Ft. of NFVA	0.15	0.20	0.26	0.33	0.41	0.49	0.59	0.69	0.80	0.92

4.2.11 Hood Vents and Roof Jacks

4.2.11(a) (Fig. 40-8, Table 40-17, and Table 40-18)

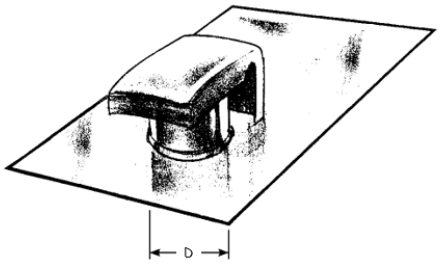


FIG. 40-8: HOOD VENT

TABLE 40-17: SQ. FT. OF NFVA FOR HOOD VENTS AND ROOF JACKS— ¼" SCREEN (REDUCTION FACTOR = 0.90)

	Diameter									
	6"	7"	8"	9"	10"	11"	12"	13"	14"	15"
Sq. Ft. of NFVA	0.18	0.24	0.31	0.40	0.49	0.59	0.71	0.83	0.96	1.10

TABLE 40-18: SQ. FT. OF NFVA FOR HOOD VENTS AND ROOF JACKS— ⅛" SCREEN (REDUCTION FACTOR = 0.75)

	Diameter									
	6"	7"	8"	9"	10"	11"	12"	13"	14"	15"
Sq. Ft. of NFVA	0.15	0.20	0.26	0.33	0.41	0.49	0.59	0.69	0.80	0.92

4.2.12 Eyebrow Vents

4.2.12(a) (Fig. 40-9, Table 40-19, and Table 40-20)

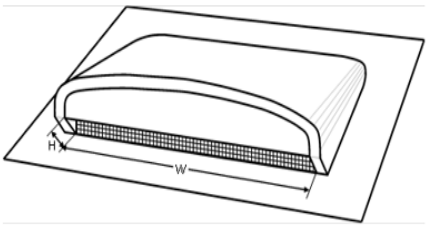


FIG. 40-9: EYEBROW VENT

TABLE 40-19: SQ. FT. OF NFVA FOR EYEBROW VENTS—¼" SCREEN, NO LOUVERS (REDUCTION FACTOR = 0.90)

		Width							
		10"	12"	14"	15"	16"	18"	20"	22"
Height	3"	0.19	0.23	0.26	0.28	0.30	0.34	0.38	0.41
	5"	0.31	0.38	0.44	0.47	0.50	0.56	0.63	0.69
	6"	0.38	0.45	0.53	0.56	0.60	0.68	0.75	0.83
	7"	0.44	0.53	0.61	0.66	0.70	0.79	0.88	0.96
	7.5"	0.47	0.56	0.66	0.70	0.75	0.84	0.94	1.03
	8"	0.50	0.60	0.70	0.75	0.80	0.90	1.00	1.10
	8.5"	0.53	0.64	0.74	0.80	0.85	0.96	1.06	1.17
	9"	0.56	0.68	0.79	0.84	0.90	1.01	1.13	1.24

TABLE 40-20: SQ. FT. OF NFVA FOR EYEBROW VENTS—1/4" OR 1/8" SCREEN WITH LOUVERS (REDUCTION FACTOR =0.75)

		Width							
		10"	12"	14"	15"	16"	18"	20"	22"
Height	3"	0.16	0.19	0.22	0.23	0.25	0.28	0.31	0.34
	5"	0.26	0.31	0.36	0.39	0.42	0.47	0.52	0.57
	6"	0.31	0.38	0.44	0.47	0.50	0.56	0.63	0.69
	7"	0.36	0.44	0.51	0.55	0.58	0.66	0.73	0.80
	7.5"	0.39	0.47	0.55	0.59	0.63	0.70	0.78	0.86
	8"	0.42	0.50	0.58	0.63	0.67	0.75	0.83	0.92
	8.5"	0.44	0.53	0.62	0.66	0.71	0.80	0.89	0.97
	9"	0.47	0.56	0.66	0.70	0.75	0.84	0.94	1.03

4.2.13 Dormer Vents

4.2.13(a) (Fig. 40-10 and Table 40-21)

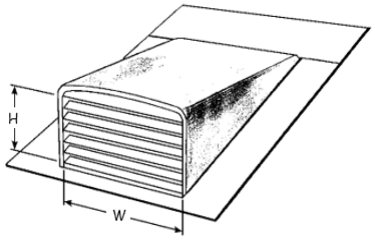


FIG. 40-10: DORMER VENT

TABLE 40-21: SQ. FT. OF NFVA FOR DORMER VENTS—1/4" OR 1/8" SCREEN WITH METAL LOUVERS (REDUCTION FACTOR = 0.75)

		Width							
		10"	12"	14"	15"	16"	18"	20"	22"
Height	5"	0.26	0.31	0.36	0.39	0.42	0.47	0.52	0.57
	6"	0.31	0.38	0.44	0.47	0.50	0.56	0.63	0.69
	7"	0.36	0.44	0.51	0.55	0.58	0.66	0.73	0.80
	7.5"	0.39	0.47	0.55	0.59	0.63	0.70	0.78	0.86
	8"	0.42	0.50	0.58	0.63	0.67	0.75	0.83	0.92
	8.5"	0.44	0.53	0.62	0.66	0.71	0.80	0.89	0.97
	9"	0.47	0.56	0.66	0.70	0.75	0.84	0.94	1.03

4.2.14 Roof Ridge Vents

4.2.14(a) (Fig. 40-11 and Table 40-22)

4.2.14(a1) Several styles of ridge vent exist, each with different NFVA specifications. When possible, measure the openings and apply reduction factor 0.50. The last option is to use Table 40-22 only when the manufacturer's NFVA specifications are not available.

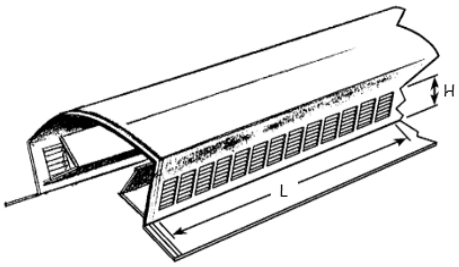


FIG. 40-11: ROOF RIDGE VENT

TABLE 40-22: SQ. FT. OF NFVA FOR ROOF RIDGE VENTS WITH LOUVERS (REDUCTION FACTOR = 0.50)

Height					
1"	1.5"	2"	2.5"	3"	3.5"
0.042	0.063	0.083	0.104	0.125	0.146
Multiply the factor shown above by linear feet of vent.					

4.3. Repair Procedure

4.3.1 Clean or replace the existing screen if the opening is clogged.

4.3.2 Install a replacement screen with ⅛"–¼" mesh when:

4.3.2 (a) The existing screen has tears or gaps or

4.3.2 (b) The screen is missing

4.4. Installation Procedure

4.4.1 Order of Installation

4.4.1 (a) All exhaust systems that terminate in the attic must be vented outdoors before any attic ventilation or insulation is installed.

4.4.1 (b) When ceiling insulation will be installed, attic ventilation must be installed before ceiling insulation.

4.4.2 Attic Vent Placement—All Vents

4.4.2 (a) The required NFVA shall be approximately evenly distributed along the lengths of at least two opposite sides to provide cross-ventilation.

4.4.2 (b) The following may be used as upper vents:

4.4.2 (b1) Gable vents installed in the upper ⅓ of the gable wall

4.4.2 (b2) Roof jacks (e.g., eyebrow, dormer, mushroom and hood)

4.4.2 (b3) Wind turbines

4.4.2 (b4) Ridge vents

4.4.2 (c) The following may be used as lower vents:

4.4.2 (c1) Eave and soffit vents shall be used when possible.

4.4.2 (c2) When eave or soffit vents cannot be installed:

- Eyebrow or dormer vents may be mounted low on the roof and
- Gable vents may be installed in the lower ⅓ of an unvented gable wall

4.4.2 (d) A 1" clearance (air path) is required between:

4.4.2 (d1) Vent opening and roof sheathing

4.4.2 (d2) Vent opening and insulation

4.4.2 (e) Install loose fill insulation blocking to comply with Section 37 Attic and Ceiling Insulation.

4.4.2 (f) Placement of attic vents will be considered for proper air flow and prevention of entry of wind driven rain or snow.

4.4.2 (g) Eave and soffit vents:

4.4.2 (g1) Baffling for attic soffit vents will be installed to:

- Ensure proper air flow
- Prevent wind washing of insulation
- Allow maximum insulation coverage
- Ensure baffle terminates above insulation

4.4.2 (g2) Unless replacing an existing vent, do not install eave and soffit vents above an operable window when prohibited by local jurisdiction.

4.4.2 (h) Turbine vents:

4.4.2 (h1) Install turbine between rafters.

4.4.2 (h2) The top of turbine must be above the roof apex.

4.4.2 (h3) Ensure at least ⅔ of the upper base flange is secured underneath roofing material.

4.4.2 (h4) Turbine vents may only be installed:

- As high vents
- On roofs with slopes greater than 2:12

4.4.2 (i) Roof jacks, including dormer, eyebrow, mushroom, and hood vents:

4.4.2 (i1) Install vents between rafters.

4.4.2 (i2) Ensure at least ⅔ of the upper base flange is secured underneath roofing material.

4.4.2 (i3) Roof jacks should not be installed

- On roofs with a slope of less than 2:12.
- As low vents when installation of eave or soffit vents is feasible.

4.4.2 (j) Vent blocking shall be installed per Section 37 Attic and Ceiling Insulation.

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 This measure does not apply to mobile homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 Installation is not allowed when only an individual unit in a multi-family building will be served.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.2 (a) DOE: Attic ventilation will only be installed in conjunction with attic/ceiling insulation.

6.1.2 (b) LIHEAP: Attic ventilation may be installed in conjunction with attic/ceiling insulation, or as a stand-alone measure.

6.1.3 This measure may be installed when justified by energy audit for a whole-building project, per Appendix D Energy Audit/Priority List Protocol.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is only installed in conjunction with attic insulation, where required by the local jurisdiction. Costs must be included in the cost of the attic insulation for the Priority List path or when calculating the savings-to-investment ratio (SIR) in the Audit path. See Appendix D Energy Audit/Priority List Protocol.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2 (a) Excerpted from 2107 SWS 4.1088.1:

7.2.2 (a1) Attic vent types will be made of corrosion-resistant material for their specific location (e.g., exterior soffit, gable end, roof) and material and intended use (e.g., metal vent on metal roof).

7.2.3 Mobile Home

7.2.3 (a) None.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Ensure that all new venting was properly installed.

8.2. Client Education

8.2.1 When turbine vents are installed, advise the client to leave them uncovered even during cold weather.

8.3. Clean-Up and Disposal Requirements

8.3.1 Installation debris and parts shall be removed from the property and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life (EUL)

9.1.1 LIHEAP: 20 years

9.1.2 DOE: Included in conjunction with Section 37 Attic and Ceiling Insulation EUL

9.2 Vents shall be made of corrosion-resistant material screened with corrosion-resistant mesh with openings of ⅛" (#8 weave mesh)–¼" (#4 weave mesh).

9.3 Powered attic vents are not allowed within the weatherization program.

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

41. Crawlspace Ventilation

Table of Contents

Crawlspace Ventilation

1. MEASURE OBJECTIVES

1.1 Installing adequate crawlspace ventilation allows outside air to circulate under the floor, reducing conditions that contribute to moisture build-up, mildew, and rot.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Existing mesh is missing or has tears or gaps

2.2. Install

2.2.1 No crawlspace ventilation exists, or existing ventilation is inadequate or

2.2.2 When replacing smaller weave mesh with larger weave mesh for additional net free ventilation area (NFVA)

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1. Do Not Repair

3.1.1 Repair of mesh would make the NFVA inadequate

3.2. Do Not Install

3.2.1 The existing crawlspace ventilation is adequate and functioning properly

3.2.2 Vent installation would require cutting through a foundation consisting of masonry stem walls

3.2.3 The crawlspace is unsound or unsafe

3.2.4 The exhaust system venting terminates in the crawlspace, unless it can be vented outdoors per Section 1 General Installation Guidelines, Limited Home Repair

3.2.5 The crawlspace is inaccessible, or there is inadequate clearance per Section 1 General Installation Guidelines, Attic and Crawlspace Accessibility

3.2.6 Installation would violate the Appendix E Health and Safety Requirements

3.2.7 The client refuses after measure benefits have been explained by the assessor

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 Crawlspace ventilation may be installed as a stand-alone measure or in conjunction with floor insulation.

4.1.2 Audited Measures

4.1.2 (a) When this measure will be installed under the Low Income Home Energy Assistance Program (LIHEAP) and an energy audit is performed, if the measure will be fully leveraged or co-funded, it must comply with Appendix D Energy Audit/Priority List Protocol.

4.1.2 (b) When this measure is paid for by LIHEAP, or is co-funded with LIHEAP, and other dwelling costs are billed to DOE, DOE-specific assessment and installation policies will apply.

4.1.3 Replacing smaller weave mesh vents with larger weave mesh screen is allowed if additional NFVA is required.

4.1.4 All venting shall be unobstructed.

4.1.5 Knob-and-tube (K&T) wiring: When K&T wiring is present in the crawlspace, follow the requirements in Section 1 General Installation Guidelines, Knob & Tube (K&T) Wiring Guidelines.

4.1.6 Vent Composition

4.1.6(a) Screens must be clean, and vents must be free of insulation and other obstructions.

4.1.6(b) ⅛"–¼" mesh screen is required on new vents.

4.1.7 Amount of Crawlspace Ventilation

4.1.7(a) The required NFVA shall conform with local code.

4.1.7(b) The existing crawlspace NFVA shall be calculated using the NFVA tables, reduction factors, and NFVA calculations for specific vent types in the following sections.

4.1.7(c) Total NFVA of the openings:

4.1.7(c1) 1 sq. ft. of NFVA is required per 150 sq. ft. of under-floor area with cross-ventilation. (Table 41-1)

4.1.7(c2) 1 sq. ft. of NFVA per 1500 sq. ft. of under-floor area with cross-ventilation (Table 41-2) is allowed when:

- Vents are installed within 3' of each corner
- The under-floor ground surface area is covered by a Class I vapor retarder and vent openings provide cross-ventilation

4.1.7(c3) Local code requirements apply if more stringent.

TABLE 41-1: SQ. FT. OF NFVA FOR A 1:150 RATIO

		Area Width															
		10'	12'	14'	16'	18'	20'	22'	24'	26'	28'	30'	32'	34'	36'	38'	40'
Area Length	10'	0.7	0.8	0.9	1.1	1.2	1.3	1.5	1.6	1.7	1.9	2.0	2.1	2.3	2.4	2.5	2.7
	12'	0.8	1.0	1.1	1.3	1.4	1.6	1.8	1.9	2.1	2.2	2.4	2.6	2.7	2.9	3.0	3.2
	14'	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.5	3.7
	16'	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.1	4.3
	18'	1.2	1.4	1.7	1.9	2.2	2.4	2.6	2.9	3.1	3.4	3.6	3.8	4.1	4.3	4.6	4.8
	20'	1.3	1.6	1.9	2.1	2.4	2.7	2.9	3.2	3.5	3.7	4.0	4.3	4.5	4.8	5.1	5.3
	22'	1.5	1.8	2.1	2.3	2.6	2.9	3.2	3.5	3.8	4.1	4.4	4.7	5.0	5.3	5.6	5.9
	24'	1.6	1.9	2.2	2.6	2.9	3.2	3.5	3.8	4.2	4.5	4.8	5.1	5.4	5.8	6.1	6.4
	26'	1.7	2.1	2.4	2.8	3.1	3.5	3.8	4.2	4.5	4.9	5.2	5.5	5.9	6.2	6.6	6.9
	28'	1.9	2.2	2.6	3.0	3.4	3.7	4.1	4.5	4.9	5.2	5.6	6.0	6.3	6.7	7.1	7.5
	30'	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6	8.0
	32'	2.1	2.6	3.0	3.4	3.8	4.3	4.7	5.1	5.5	6.0	6.4	6.8	7.3	7.7	8.1	8.5
	34'	2.3	2.7	3.2	3.6	4.1	4.5	5.0	5.4	5.9	6.3	6.8	7.3	7.7	8.2	8.6	9.1
	36'	2.4	2.9	3.4	3.8	4.3	4.8	5.3	5.8	6.2	6.7	7.2	7.7	8.2	8.6	9.1	9.6
	38'	2.5	3.0	3.5	4.1	4.6	5.1	5.6	6.1	6.6	7.1	7.6	8.1	8.6	9.1	9.6	10.1
	40'	2.7	3.2	3.7	4.3	4.8	5.3	5.9	6.4	6.9	7.5	8.0	8.5	9.1	9.6	10.1	10.7

Table 41-2: Sq. Ft. of NFVA for a 1:1500 Ratio

Area Length \ Area Width	10'	12'	14'	16'	18'	20'	22'	24'	26'	28'	30'	32'	34'	36'	38'	40'
10'	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
12'	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3
14'	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4
16'	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4
18'	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5
20'	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5
22'	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6
24'	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6
26'	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7
28'	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7
30'	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.8	0.8
32'	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.9
34'	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9
36'	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0
38'	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0
40'	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.1

4.1.8 Reduction Factors

4.1.8(a) Example: A vent has ¼" screen (no louvers), with a vent opening (excluding the frame) that is 2½" x 17".

4.1.8(a1) The area of the opening is 2½" x 17" = 42.5 sq. in.

4.1.8(a2) Table 41-3 shows the reduction factor for this a vent with ¼" screen and no louvers is 90%.

4.1.8(a3) 42.5 sq. in. x 0.90 = 38.25 sq. in.

4.1.8(a4) Divide sq. in. by 144 to calculate sq. ft.: 38.25/144 = 0.27 sq. ft. of NFVA

Table 41-3: Screen and Louver NFVA Reduction Factors

¼" Screen, No Louvers	⅛" Screen, No Louvers	1/16" Screen, No Louvers	Metal Louvers with or without ¼" or ⅛" Screen	Wood Louvers with or without ¼" or ⅛" Screen
0.90 (90%)	0.75 (75%)	0.50 (50%)	0.75 (75%)	0.25 (25%)

4.2. Vent Tables

4.2.1 The tables on the following pages Table 41-4 and Table 41-5 can be used to determine the NFVA provided by crawlspace venting. The NFVA shown includes the reduction factor and is given in sq. ft.

4.2.2 When vent measurements are between the sizes listed, calculate manually.

4.2.3 Rectangular Vents

4.2.3(a) (Table 41-4 and Table 41-5)

TABLE 41-4: SQ. FT. OF NFVA FOR RECTANGULAR VENTS—¼"-INCH MESH SCREEN, NO LOUVERS (REDUCTION FACTOR = 0.90)

		Length								
		10"	12"	13"	14"	14.5"	16"	18"	21"	22.5"
Height	3"	0.19	0.23	0.24	0.26	0.27	0.30	0.34	0.39	0.42
	3.5"	0.22	0.26	0.28	0.31	0.32	0.35	0.39	0.46	0.49
	4"	0.25	0.30	0.33	0.35	0.36	0.40	0.45	0.53	0.56
	4.5"	0.28	0.34	0.37	0.39	0.41	0.45	0.51	0.59	0.63
	5"	0.31	0.38	0.41	0.44	0.45	0.50	0.56	0.66	0.70
	5.5"	0.34	0.41	0.45	0.48	0.50	0.55	0.62	0.72	0.77

TABLE 41-5: SQ. FT. OF NFVA FOR RECTANGULAR VENTS—⅛" SCREEN, NO LOUVERS (REDUCTION FACTOR = 0.75)

		Length								
		10"	12"	13"	14"	14.5"	16"	18"	21"	22.5"
Height	3"	0.16	0.19	0.20	0.22	0.23	0.25	0.28	0.33	0.35
	3.5"	0.18	0.22	0.24	0.26	0.26	0.29	0.33	0.38	0.41
	4"	0.21	0.25	0.27	0.29	0.30	0.33	0.38	0.44	0.47
	4.5"	0.23	0.28	0.30	0.33	0.34	0.38	0.42	0.49	0.53
	5"	0.26	0.31	0.34	0.36	0.38	0.42	0.47	0.55	0.59
	5.5"	0.29	0.34	0.37	0.40	0.42	0.46	0.52	0.60	0.64

4.3. Repair Procedure

4.3.1 Clean or replace the existing screen if the opening is clogged.

4.3.2 Install a replacement screen with ⅛"–¼" mesh when:

4.3.2(a) The existing screen has tears or gaps or

4.3.2(b) The screen is missing

4.4. Installation Procedure

4.4.1 Order of Installation

4.4.1(a) All exhaust systems that terminate in the crawlspace must be vented outdoors before crawlspace ventilation or insulation is installed.

4.4.1(b) Plumbing leaks shall be repaired before crawlspace upgrade in accordance with the International Residential Code (IRC) and Section 1 General Installation Guidelines, Limited Home Repair

4.4.1(c) When floor insulation will be installed, crawlspace ventilation must be installed before floor insulation.

4.4.2 Crawlspace Vent Placement

4.4.2(a) The required NFVA shall be approximately evenly distributed along the lengths of opposite sides, starting within 3' of each corner, when possible (Fig. 41-1).

4.4.2(b) Vent openings shall provide cross-ventilation for each separate space.

4.4.2(c) Foundation vents shall not be obstructed by insulation.

4.4.2(c1) If new insulation is installed:

- 12" minimum clearance is required without blocking.
- 3" minimum clearance is required when blocking is made of minimum 0.007" sheet metal.

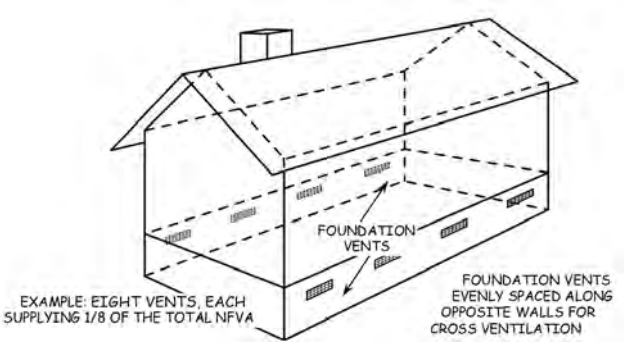


FIG. 41-1: CRAWLSPACE VENT PLACEMENT

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes except as specified below.

5.1.2 Vent openings in the skirting shall provide 1½ sq. ft. of venting for each 25' of mobile home length.

5.1.3 Installed vents shall be:

5.1.3(a) Provided on at least two opposite sides and

5.1.3(b) Located as close to all corners as practical

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 Installation is not allowed when only an individual unit in a multi-family building will be served.

6.1.2 When the measure will be included in a multi-family whole-building project, the Appendix F Multi-Family Standards apply.

6.1.2(a) DOE: Crawlspace ventilation will only be installed in conjunction with floor insulation.

6.1.2(b) LIHEAP: Crawlspace ventilation may be installed in conjunction with floor insulation, or as a stand-alone measure.

6.1.3 This measure may be installed when justified by energy audit for a whole-building project, per Appendix D Energy Audit/Priority List Protocol.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is only installed in conjunction with floor insulation, where required by the local jurisdiction. Costs must be included in the cost of the floor insulation for the Priority List path or when calculating the savings-to-investment ratio (SIR) in the Audit path. See Appendix D Energy Audit/Priority List Protocol.

7.2. Installation Requirements

7.2.1 Installation requirements for DOE are the same as those for LIHEAP except as specified below.

7.2.2 Single-Family

7.2.2(a) None.

7.2.3 Mobile Home

7.2.3(a) Excerpted from: 2017 SWS 2.0501.2:

7.2.3(a1) Pier and skirting foundations will be vented in accordance with local climate conditions or code as required.

7.2.3(a2) Occupants will be educated on purpose, operation, and maintenance of vents.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 A check shall be made that all new venting was properly installed.

8.2. Client Education

8.2.1 None.

8.3. Clean-Up and Disposal Requirements

8.3.1 Installation debris and parts shall be removed from the property and disposed of properly.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life (EUL)

9.1.1 LIHEAP: 20 years

9.1.2 DOE: Included in conjunction with Section 39 Floor Insulation EUL

9.2 Vents shall be made of corrosion-resistant material screened with corrosion-resistant mesh with openings of ⅛" (#8 weave mesh)–¼" (#4 weave mesh).

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

42. Dishwashers

Table of Contents

Dishwashers

1. MEASURE OBJECTIVES

1.1 Replacement of a standard dishwasher with an ENERGY STAR®-certified unit to reduce energy and water consumption.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure

2.2. Install

2.2.1 The existing dishwasher is not ENERGY STAR®-certified, or

2.2.2 A dishwasher is not present but the infrastructure is intact (e.g., water hook-up, drain, electrical receptacle) are present and an approved CSD waiver is obtained, or

2.2.3 One or more of the following operational issues are present in the existing dishwasher:

2.2.3(a) The appliance is inoperable or does not operate as intended (does not wash or drain): or

2.2.3(b) Has defects that compromise efficiency (such as a leak or failing motor); or

2.2.3(c) Has a Health and Safety condition that will be resolved by installing a new dishwasher (such as an electrical hazard).

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 No appropriate location is available for one or more of the following reasons:

3.1.1 Inadequate access to remove the existing unit and install a new unit.

3.1.2 The flooring is structurally inadequate to properly support the weight of the unit.

3.1.3 Clearance requirements cannot be met, including clearance for proper door swing.

3.1.4 The dishwasher cannot be installed in a level, plumb, and stable condition.

3.2 The electrical outlet used by the existing dishwasher is not properly installed (e.g., it is hazardous, is not grounded, or has reversed polarity) and cannot be repaired.

3.3 A suitable drain system is not available to accept the discharge of the dishwasher on its largest load setting.

3.4 A suitable water supply is not available.

3.5 Installation would violate the Appendix E Health and Safety Requirements.

3.6 The client refuses after measure benefits have been explained by the assessor.

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 When required by the local jurisdiction, a building permit to replace the existing dishwasher shall be obtained and finalized.

4.1.2 Sizing Limitations

4.1.2(a) Sizing limitations for replacement dishwashers shall be in accordance with the size and capacity of the existing unit.

4.2. Installation Procedure

4.2.1 Installation Location

4.2.1(a) The installation location shall provide the dishwasher manufacturer's minimum specified clearances on all sides.

4.2.1(b) Ample room to fully open the dishwasher door without being obstructed by surrounding cabinets or appliances shall be available.

4.2.1(c) Dishwashers located next to walls or in corner locations shall allow for a minimum of 2" clearance between the side of the dishwasher door and the wall or cabinet (Fig. 42-1).

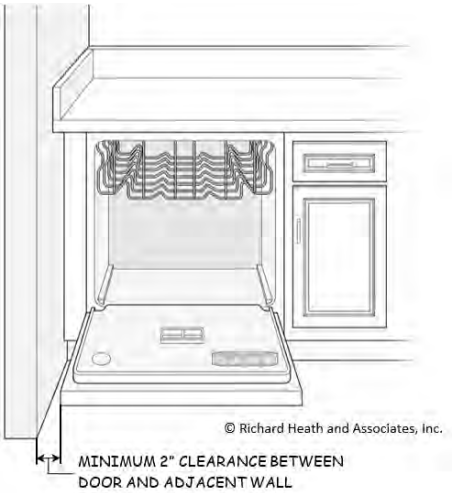


FIG. 42-1: DISHWASHER IN CORNER LOCATION

4.2.2 Leveling

4.2.2(a) Individual feet shall be adjusted to properly level the dishwasher with all four feet resting on the floor.

4.2.2(b) After leveling, the locking nuts shall be tightened to hold the feet in place.

4.2.3 Attachment and Securing

4.2.3(b1) Manufacturer provided mounting brackets shall be installed to secure the dishwasher to the countertop or surrounding cabinets.

4.2.3(b2) The dishwasher shall not be secured to countertops that are granite, marble, stone, or any other material that can be damaged by being drilled.

4.2.4 Water Supply

4.2.4(a) Water supply to the dishwasher shall have a manual shutoff valve, located under the sink and within 6' of the dishwasher, unless otherwise specified by the dishwasher manufacturer.

4.2.4(b) Water pressure at the hot water shutoff valve shall be within manufacturer's specified minimums.

4.2.4(c) Water temperature at the shutoff valve shall be a minimum of 120°F and no more than 150°F unless otherwise specified by the dishwasher manufacturer.

4.2.4(d) All water connections shall be tight and sealed with non-toxic pipe joint compound.

4.2.4(e) All hoses shall be new. Existing hoses shall not be re-used.

4.2.5 Drain System

4.2.5(a) Drain must be functional and have adequate capacity to accept the water discharge of the dishwasher on the largest load setting.

4.2.5(b) An approved air gap fitting shall be installed on the discharge side of the dishwasher with the flood-level marking at or above the flood level of the sink or drainboard, whichever is higher.

4.2.5(c) Manufacturer supplied drain hose shall be installed. When the supplied drain hose is not long enough, a new drain hose of shortest possible length may be installed.

4.2.6 Electrical Requirements

4.2.6(a) Overcurrent protection and conductor size must be adequate.

4.2.6(b) Electrical supply shall be 120-volt, minimum 15-amp, and shall meet manufacturer's specifications.

4.2.6(c) The dishwasher must be hardwired or plugged directly into a receptacle that is properly grounded and the receptacle:

4.2.6(c1) Shall be within 6' of the installation location, or as specified by the manufacturer.

4.2.6(c2) A GFCI-protected circuit or outlet, or a switched outlet, shall not be used unless required by manufacturer's instructions or local code.

4.2.6(c3) Shall not be shared with another appliance when required by manufacturer's instructions or local code.

4.2.6(d) If the receptacle cover plate is cracked, damaged, or missing, a new one shall be installed.

4.2.6(e) Permanent three-prong adapters and/or extensions cords are not allowed (Fig. 42-2).

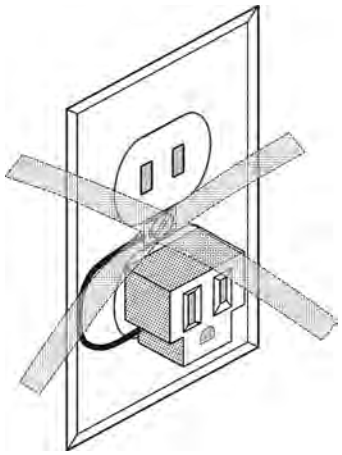


FIG. 42-2: USE OF ADAPTER IS NOT ALLOWED

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.1(a) Common area installation (e.g., in a kitchen, utility room, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Manufacturer's start-up/test procedures shall be followed to ensure proper operation of the dishwasher.

8.1.2 Perform troubleshooting per the manufacturer's instructions as needed to correct problems.

8.2. Client Education

8.2.1 The occupant will be provided with:

8.2.1(a) Specific information on the proper maintenance of the equipment

8.2.1(b) Warranty information

8.2.1(c) Operation manuals

8.2.1(d) Installer contact information

8.3. Clean-Up and Disposal Requirements

8.3.1 Replaced appliance and materials will be recycled or disposed of in accordance with federal, state, or local regulations.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 11 years

9.1.2 DOE: Not applicable to this measure.

9.2 Replacement Dishwasher

9.2.1 The replacement appliance shall:

9.2.1(a) Be ENERGY STAR®-certified

9.2.1(b) Bear a yellow Energy Guide label

9.2.1(c) Feature an auto-sensing cycle or multiple cycle options, such as:

9.2.1(c1) Energy-saving wash

9.2.1(c2) Light duty

9.2.1(c3) Heated dry OFF

9.2.1(d) Be sized to match the size and capacity of the existing unit.

9.3 Drain Hose and Fittings

9.3.1 AHAM/IAPMO tested

9.3.2 Heat and detergent resistant

9.4 Hot Water Supply Line

9.4.1 NSF/ANSI 61 certified

9.4.2 Copper tubing or flexible braided stainless steel

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

43. High-Efficiency Clothes Washers

Table of Contents

High-Efficiency Clothes Washers

1. MEASURE OBJECTIVES

1.1 Replacement of a standard clothes washer with an ENERGY STAR®-certified unit to reduce energy and water consumption.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure

2.2. Install

2.2.1 The existing clothes washer is not ENERGY STAR®-certified, or

2.2.2 A clothes washer is not present but the infrastructure is intact (e.g., water hook-ups, drain, electrical receptacle) and an approved CSD waiver is obtained, or

2.2.3 One or more of the following operational issues are present in the existing washer:

2.2.3(a) The appliance is inoperable or does not operate as intended (e.g., failure to drain, inoperable control panel, etc.)

2.2.3(b) Has defects that compromise efficiency (such as a leak or failing motor), or

2.2.3(c) Has a Health and Safety condition that will be resolved by installing a new clothes washer (such as an electrical hazard).

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 No appropriate location is available for one or more of the following reasons:

3.1.1 Inadequate access to remove the existing unit and install a new unit.

3.1.2 The flooring is structurally inadequate to properly support the weight of the unit and will not be repaired prior to installation of the unit.

3.1.3 Clearance requirements cannot be met, including clearance for proper door swing.

3.1.4 The clothes washer cannot be installed in a level, plumb, and stable condition.

3.1.5 Installation location is outdoors, unprotected, and exposed to weather.

3.2 The electrical outlet used by the existing clothes washer is not properly installed (e.g., it is hazardous, is not grounded, or has reversed polarity) and cannot be repaired.

3.3 A suitable drain system is not available to accept the discharge of the clothes washer on its largest load setting.

3.4 A suitable water supply is not available.

3.5 Installation would violate the Appendix E Health and Safety Requirements.

3.6 The client refuses after measure benefits have been explained by the assessor.

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 When required by the local jurisdiction, a building permit to replace the existing clothes washer shall be obtained and finalized.

4.1.2 Sizing Limitations

4.1.2(a) Sizing limitations for replacement clothes washers shall be in accordance with the size and capacity of the existing unit.

4.1.3 Accessibility

4.1.3(a) If a clothes washer qualifies for replacement, the client or occupants have physical limitations, and by request of the client only, a front-loading type washer may be installed to improve accessibility.

4.1.3(b) If a pedestal is needed for accessibility for the front-loading washer only, installation of a basic pedestal model will be allowed.

4.1.3(b1) The cost of the installed pedestal shall be billed to LIHEAP Limited Home Repair.

- If a pedestal to improve accessibility also is needed for a clothes dryer that will not be installed, an approved CSD waiver is required.

4.1.4 Stackable Units and Stacked Laundry Centers

4.1.4(a) A stackable clothes washer and dryer, or a stacked laundry center may be installed when both the clothes washer and dryer are being replaced as stand-alone measures and adequate clearances/infrastructure (dryer moisture exhaust, water supply, etc.) are available to allow for installation, and

4.1.4(b) When accepted by the customer after the differences have been explained.

4.2. Installation Procedure

4.2.1 Installation Location

4.2.1(a) The installation location shall provide the clothes washer manufacturer's minimum specified clearances on all sides.

4.2.1(b) Ample room shall be available to fully open the clothes washer door (i.e., minimum 90° door swing) shall be available.

4.2.2 Leveling

4.2.2(a) Individual feet shall be adjusted to properly level the clothes washer with all four feet resting on the floor (Fig. 43-1).

4.2.2(b) After leveling, the locking nuts shall be tightened to hold the feet in place.

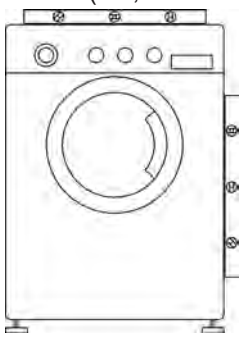


FIG. 43-1: CLOTHES WASHER IN A LEVEL, STABLE POSITION

4.2.3 Pedestal

4.2.3(a) When an optional matching pedestal is utilized, it shall be installed as instructed and leveled as described above.

4.2.4 Water Supply

4.2.4(a) Water pressure at the hot and cold shutoff valve shall be within the clothes washer manufacturer's specifications (not too high or low).

4.2.4(b) Hot and cold shutoff valve must be located within 4' of the clothes washer, or as allowed by the manufacturer.

4.2.4(c) Two fill hoses shall not be coupled together for extra length unless the manufacturer provides coupling parts and instructions.

4.2.4(d) All hoses shall be new. Existing hoses shall not be reused.

4.2.4(e) All hoses shall be properly connected and free of leaks, avoiding over-tightening.

4.2.5 Drain Hose

4.2.5(a) Drain hose shall terminate in a suitable drain (standpipe, laundry sink, or floor drain) with adequate capacity to accept water discharge on the largest load setting.

4.2.5(b) When installed in a standpipe,

4.2.5(b1) A U-shape bend must be present in the drain hose at the top of the standpipe, and

4.2.5(b2) An adequate gap for air between the hose and pipe shall be present.

4.2.5(c) Drain hose shall be properly secured (e.g., with cable tie).

4.2.6 Drain System

4.2.6(a) Must be functional and suitable to accept the maximum water discharge from the clothes washer.

4.2.6(b) If the discharge hose connects to a drainpipe in/near the floor, a siphon break must be installed above the bottom of the washer in accordance with manufacturer's instructions or local code.

4.2.7 Electrical Requirements

4.2.7(a) Overcurrent protection and conductor size must be adequate.

4.2.7(b) Electrical supply shall be 120-volt, minimum 15-amp, and shall meet manufacturer's specifications.

4.2.7(c) The clothes washer must be plugged directly into a receptacle that is:

4.2.7(c1) A properly grounded three-prong receptacle with a functioning equipment grounding conductor (Fig. 43-2)

4.2.7(c2) GFCI-protected (when a grounding conductor is not present and will not be provided) unless otherwise specified by manufacturer's instructions or local code.

4.2.7(d) If the receptacle cover plate is cracked, damaged, or missing, a new one shall be installed.

4.2.7(e) Permanent three-prong adapters and/or extensions cords are not allowed.

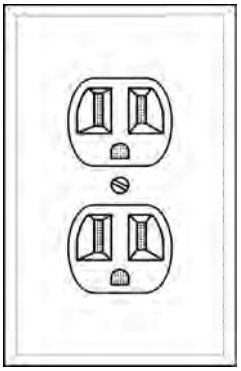


FIG. 43-2: 120-VOLT RECEPTACLE WITH INTACT COVER PLATE

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.1(a) Common area installation (e.g., shared laundry facility, utility room, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Manufacturer's start-up/test procedures shall be followed to ensure proper operation of the clothes washer.

8.1.2 The test cycle shall determine if:

8.1.2(a) The washer fills and drains properly

8.1.2(b) The drain system has adequate capacity and functions properly

8.1.2(c) The washer is stable during the spin cycle

8.1.2(d) There are no water leaks

8.1.3 Perform troubleshooting per the manufacturer's instructions as needed to correct problems.

8.2. Client Education

8.2.1 The occupant will be provided with:

8.2.1(a) Specific information on the proper maintenance of the equipment

8.2.1(b) Warranty information

8.2.1(c) Operation manuals

8.2.1(d) Installer contact information

8.3. Clean-Up and Disposal Requirements

8.3.1 Replaced appliance and materials will be recycled or disposed of in accordance with federal, state, or local regulations.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 11 years

9.1.2 DOE: Not applicable to this measure

9.2 Replacement Clothes Washer

9.2.1 The replacement appliance shall:

9.2.1(a) Be ENERGY STAR®-certified

9.2.1(b) Bear a yellow Energy Guide label

9.2.1(c) Have the following features:

9.2.1(c1) High-speed spin cycle

9.2.1(c2) Several options for water level and temperature settings, including a cold-water setting

9.2.1(d) Be sized to match the size and capacity of the existing unit.

9.2.2 When allowed to be installed, a Clothes Washer Pedestal shall:

9.2.2(a) Meet manufacturer specifications

9.2.2(b) Be a basic model, without additional special features.

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

44. Clothes Dryers

Table of Contents

Clothes Dryers

1. MEASURE OBJECTIVES

1.1 Replacement of a standard clothes dryer with an ENERGY STAR®-certified unit to reduce energy consumption.

2. INSTALL THIS MEASURE WHEN:

2.1. Repair

2.1.1 Not applicable to this measure

2.2. Install

2.2.1 The existing clothes dryer is not ENERGY STAR®-certified, or

2.2.2 A clothes dryer is not present but the infrastructure is intact (e.g., moisture exhaust, electrical receptacle, gas line [for gas dryers]), and an approved CSD waiver is obtained, or

2.2.3 One or more of the following operational issues are present in the existing dryer:

2.2.3(a) The appliance is inoperable or does not operate as intended (e.g., inoperable control panel, broken heating element, etc.)

2.2.3(b) Has defects that compromise efficiency (such as a failing motor)

2.2.3(c) Has a Health and Safety condition that will be resolved by installing a new clothes dryer (such as an electrical or CAS hazard).

3. DO NOT INSTALL THIS MEASURE WHEN:

3.1 No appropriate location is available for one or more of the following reasons:

3.1.1 Inadequate access to remove the existing unit and install a new unit.

3.1.2 The flooring is structurally inadequate to properly support the weight of the unit and will not be repaired prior to installation of the unit.

3.1.3 Clearance requirements cannot be met, including clearance for proper door swing.

3.1.4 The clothes dryer cannot be installed in a level, plumb, and stable condition.

3.1.5 Installation location is outdoors, unprotected, and exposed to weather.

3.1.6 Gas clothes dryers: Installation location does not provide adequate makeup air and correction is not feasible.

3.2 The electrical outlet used by the existing clothes dryer is not properly installed (e.g., it is hazardous, is not grounded, or has reversed polarity) and cannot be repaired.

3.3 A suitable clothes dryer moisture exhaust is not available.

3.4 Installation would violate the Appendix E Health and Safety Requirements.

3.5 The client refuses after measure benefits have been explained by the assessor.

4. INSTALLATION GUIDELINES

4.1. General Requirements

4.1.1 When required by the local jurisdiction, a building permit to replace the existing clothes dryer shall be obtained and finalized.

4.1.2 Sizing Limitations

4.1.2(a) Sizing limitations for replacement clothes dryers shall be in accordance with the size and capacity of the existing unit.

4.1.3 Lack of a clothes washer shall not affect the feasibility of the clothes dryer measure.

4.1.4 Accessibility

4.1.4(a) If a clothes dryer qualifies for installation, and a pedestal is needed to improve accessibility for a client or occupants with physical limitations, installation of a basic pedestal will be permitted.

4.1.4(a1) The cost of the installed pedestal shall be billed to LIHEAP Limited Home Repair.

4.1.5 Stackable Units and Stacked Laundry Centers

4.1.5(a) A stackable clothes washer and dryer, or a stacked laundry center may be installed when both the clothes washer and dryer are being replaced as standalone measures and adequate clearances/infrastructure (dryer moisture exhaust, water supply, etc.) are available to allow for installation, and

4.1.5(b) When accepted by the customer after the differences have been explained.

4.2. Installation Procedure

4.2.1 Installation Location

4.2.1(a) Installation location shall provide the clothes dryer manufacturer's minimum specified clearances on all sides.

4.2.1(b) Ample room shall be available to fully open the clothes dryer door (i.e., minimum 90° door swing) shall be available.

4.2.1(c) Gas clothes dryers – makeup air:

4.2.1(c1) Installation location shall provide the clothes dryer manufacturer's minimum specified makeup air.

4.2.1(c2) When installed in a closet, the closet shall have a minimum opening of 100 sq. in. for makeup air or as specified by the manufacturer.

4.2.2 Leveling

4.2.2(a) Individual feet shall be adjusted to properly level the clothes washer with all four feet resting on the floor (Fig. 44-1).

4.2.2(b) After leveling, the locking nuts shall be tightened to hold the feet in place.

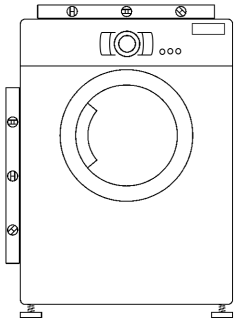


FIG. 44-1: CLOTHES DRYER IN LEVEL, STABLE POSITION

4.2.3 Pedestal

4.2.3(a) When an optional matching pedestal is utilized, it shall be installed as instructed and leveled as described above.

4.2.4 Electrical Requirements

4.2.4(a) Overcurrent protection and conductor size must be adequate.

4.2.4(b) Electrical supply shall be 220-volt (or 120-volt if appropriate for the dryer being installed) and shall meet manufacturer's specifications.

4.2.4(c) The clothes dryer must be plugged directly into a receptacle that is:

4.2.4(c1) A properly grounded three-prong receptacle with a functioning equipment grounding conductor (Fig. 44-2)

4.2.4(c2) GFCI-protected (when a grounding conductor is not present and will not be provided) unless otherwise specified by manufacturer's instructions or local code.

4.2.4(d) If the receptacle cover plate is cracked, damaged, or missing, a new one shall be installed.

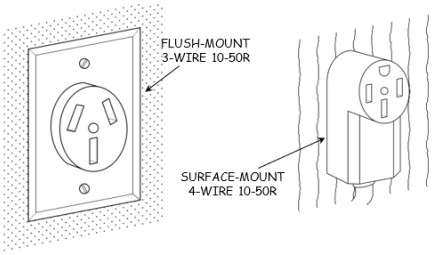


FIG. 44-2: 220-VOLT RECEPTACLE

4.2.5 Extension Cords and Adapters

4.2.5(a) Gas dryers

4.2.5(a1) The grounding prong shall not be removed from the power cord

4.2.5(a2) An ungrounded three-prong adapter shall not be used

4.2.5(a3) An extension cord shall not be used

4.2.5(b) Electric dryers

4.2.5(b1) Permanent three-prong adapters and/or extensions cords are not allowed.

4.2.6 Gas Requirements (Gas Dryers Only)

4.2.6(a) Fuel gas supply line shall be no more than 6-feet from the dryer to the appliance valve.

4.2.6(b) New flexible connector with stainless-steel fitting and appliance valve shall be installed.

4.2.6(c) Threaded fittings shall be sealed with pipe thread compound or tape designed for use with gas lines.

4.2.6(d) All gas connections shall be tested for gas leaks in accordance with the Appendix A Combustion Appliance Safety Protocol.

4.2.7 Domestic Clothes Dryer Moisture Exhaust

4.2.7(a) Intake and exhaust air volume shall be compliant with the manufacturer's specifications.

4.2.7(b) Exhaust duct shall be a minimum of 4" in diameter.

4.2.7(c) Clothes dryer moisture exhaust shall not exceed 14' in total length unless otherwise specified by the clothes dryer manufacturer and local code.

4.2.7(c1) Subtract 2' from the total length (14' maximum) for each elbow, in excess of 2 elbows.

4.2.7(c2) The first 6' of pipe may be flexible duct to aid in alignment.

4.2.7(d) Moisture exhaust connections shall be secured with dryer hose clamps or aluminum tape.

4.2.7(d1) In addition to mechanical connectors, duct connections will be sealed with UL 181B or 181B-M material

4.2.7(d2) If a new dryer moisture exhaust will not be installed, the existing dryer moisture exhaust must meet the requirements above and be cleared of lint and other obstructions prior to the installation of the new clothes dryer.

4.2.8 Moisture Exhaust Termination

4.2.8(a) Moisture exhaust shall terminate on the exterior of the home and, unless otherwise specified by the manufacturer or local code, shall terminate in compliance with the following minimum clearances:

4.2.8(a1) 3' from an openable door or window

4.2.8(a2) 3' from the property line

4.2.8(a3) 10' from a window-mounted evaporative cooler or air conditioner (Fig. 44-3)

4.2.8(a4) 5' from a central air conditioner or heat pump condensing unit

4.2.8(b) Termination shall be equipped with a backdraft damper. Screens/mesh shall not be installed on the termination

4.2.8(c) Clothes dryer moisture exhaust duct shall not pass through an FAU plenum

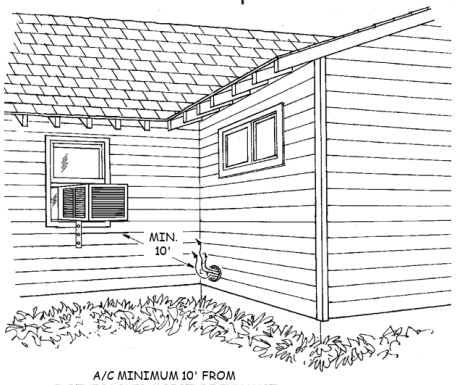


FIG. 44-3: MINIMUM CLEARANCE BETWEEN WINDOW AC AND TERMINATION

5. MOBILE HOME–SPECIFIC

5.1. Installation Requirements

5.1.1 Installation requirements for mobile homes are the same as those for conventional homes.

6. MULTI-FAMILY–SPECIFIC

6.1. Installation Requirements

6.1.1 When only an individual multi-family unit will be served, installation requirements are the same as those for conventional homes.

6.1.1(a) Common area installation (e.g., shared laundry facility, utility room, etc.) is not allowed for this measure.

7. DOE-SPECIFIC

7.1. Assessment Requirements

7.1.1 This measure is not a DOE measure.

8. POST-INSTALLATION GUIDELINES

8.1. Quality Check

8.1.1 Manufacturer's start-up/test procedures shall be followed to ensure proper operation of the clothes dryer.

8.1.2 The test cycle shall determine if:

8.1.2(a) The dryer is stable

8.1.2(b) The heating element is working

8.1.3 Perform troubleshooting per the manufacturer's instructions as needed to correct problems.

8.1.4 Gas Clothes Dryers

8.1.4(a) Post-CAS appliance repair and replacement testing will be conducted in accordance with Appendix A Combustion Appliance Safety Protocol.

8.2. Client Education

8.2.1 The occupant will be provided with:

8.2.1(a) Specific information on the proper maintenance of the equipment

8.2.1(b) Warranty information

8.2.1(c) Operation manuals

8.2.1(d) Installer contact information

8.3. Clean-Up and Disposal Requirements

8.3.1 Replaced appliance and materials will be recycled or disposed of in accordance with federal, state, or local regulations.

9. MATERIAL SPECIFICATIONS

9.1 Measure Effective Useful Life

9.1.1 LIHEAP: 11 years

9.1.2 DOE: Not applicable to this measure

9.2 Replacement Clothes Dryer

9.2.1 The replacement appliance shall:

9.2.1(a) Be ENERGY STAR®-certified

9.2.1(b) Have the following features:

9.2.1(b1) Moisture sensor

9.2.1(b2) Multiple temperature settings

9.2.1(b3) Maximum test cycle time of 80 minutes

9.2.2 When allowed to be installed, a Clothes Dryer Pedestal shall:

9.2.2(a) Meet manufacturer specifications

9.2.2(b) Be a basic model, without additional special features.

9.3 All Ducts

9.3.1 A gas or electric clothes dryer moisture exhaust shall:

9.3.1(a) Be of rigid metal and have a smooth interior surface

9.3.1(b) Be minimum 4” in diameter

9.3.1(c) Comply with clothes dryer manufacturer’s specifications and applicable local codes

9.4 Rigid duct with smooth interior surface

9.4.1 Galvanized steel: Minimum 26 gauge

9.4.2 Aluminum: Minimum 24 gauge

9.4.3 Exception: UL-listed, flexible clothes dryer transition duct not more than 6’ in length may be used to connect the dryer to a metal exhaust duct. Plastic venting material will not be used.

9.4.4 Flexible transition duct shall not be concealed within the contruction.

9.5 Moisture exhaust duct terminations

9.5.1 The termination shall be manufacturer for use with dryers and made of UL-listed aluminum, sheet metal, or ultraviolet (UV)-protected plastic with no mesh/screen.

9.6 Duct connections clamps and hangers

9.6.1 Duct connectors shall be listed stainless steel or impact-resistance plastic hose clamp style bands to be installed around a duct exterior

9.6.2 Duct hangers shall be rust- and corrison-resistant

9.7 Gas Piping and Valves

9.7.1 Gas valves

9.7.1(a) UL-listed, and

9.7.1(b) AGA- or CSA-certified

9.7.2 Flexible connectors

9.7.2(a) New, IAPMO-listed, and

9.7.2(b) Stainless steel or plastic- or epoxy-coated brass connectors

9.7.3 Fuel gas piping: Compliant with CMC, Chapter 13

10. WARRANTY

10.1 Manufacturer—1 year

10.2 Contractor—1 year

Appendix A: Combustion Appliance Safety Protocol

Photo Credit: Butte Community Action Agency

DEPARTMENT OF COMMUNITY SERVICES AND DEVELOPMENT

Effective 7/1/2023

Table of Contents

1. What Is CAS Testing?

Combustion appliance safety (CAS) testing is a critical requirement that protects residents from the effects of CO gas and other combustion products before, during and after weatherizing a home.

1.1 WHAT DOES CAS ACHIEVE?

Technicians, who work in income-qualified homes, must be able to test houses and combustion appliances properly, to ensure that everything is safe. By creating "worst case" situations with the tests, we are able to catch…and correct…many potentially harmful conditions.

The purpose of CAS testing is to:

- Detect defects and hazards with specific combustion appliances that may jeopardize the health and safety of occupants, and
- Correct defects and hazards, when feasible.

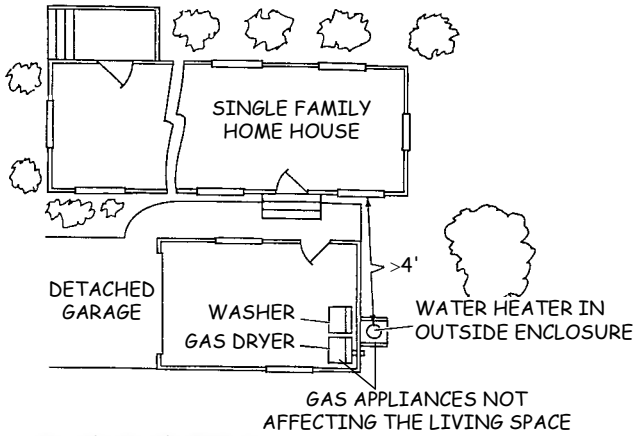
1.2 APPLIANCES THAT AFFECT THE LIVING SPACE

CAS testing shall be conducted when the home has one or more combustion appliances that "affect the living space".

1.2.1 APPLIANCES THAT AFFECT LIVING SPACE

Combustion appliances that affect the living space are:

- All space heating appliances.
- Other appliances located:
  - Partially or entirely within the living space (including closets located within the envelope but accessed from outdoors).
  - An outdoor location where any part of the appliance is within 4' of an operable door or window, or air inlet, <u>leading directly into the living space</u>.
  - In the attic or basement, or in an enclosure communicating with the attic or basement.
  - In an attached garage with *or without* a walk-thru door into the house.
  - A location where combustion products from the appliance could infiltrate a forced air duct system (e.g., in a garage or room containing supply or return plenum/ductwork).



Graphic Credit: RHA, Inc.

1.2.2 APPLIANCES <u>NOT</u> AFFECTING THE LIVING SPACE

Appliances in all *other* locations do <u>not</u> affect the living space.

1.3 CAS TESTING FEASIBILITY CRITERIA

CAS testing of combustion appliances shall occur when…

- A dwelling unit to be weatherized is equipped with one or more qualifying fuel-burning appliance(s) that affects the living space. Qualifying appliances include:
  a. Open or closed combustion;
  b. Natural gas, propane, fuel oil, kerosene
  c. Solid-fuel burning appliances (require a visual inspection only).
- Appliance is accessible.
- Repair or replacement of a fuel-burning appliance is contemplated.
- Infiltration-reduction measures shall be installed.

Combustion appliances shall NOT be CAS tested when…

- Appliance is properly abandoned (the flexible gas connector is removed, and the gas valve is capped, or the valve is removed and the line is capped).
- Performance of the CAS test would violate the CSD Asbestos Policy or Lead-Safe Weatherization Policy.
- Client refuses (see warning below).

WEATHERIZATION FEASIBILITY

In the LIHEAP, ECIP, and DOE contracts, if a client refuses Combustion Appliance Safety or CAS testing (which includes Combustion Appliance Zone or CAZ testing when required by program policy), the:

- Dwelling is deferred and shall not receive weatherization services.
- Refusal shall be documented in the CSD 542 Deferral Form by the Assessor, with client signature and date collected from the client.

1.4 RECORD-KEEPING FOR CAS TESTING

Diagnostic test results and incremental work performed shall be accurately recorded on the CSD 700 series forms, unless a home has no combustion appliances present (this is known as an "all-electric" home):

As applicable, these CSD forms shall be completed and stored in each client's file:

- CSD 700 Combustion Appliance Safety Inspection Form
- CSD 700B Interim-CAS Tests
- CSD 700C CAS Post Repair/Replacement Safety Checks

Copies of the most up-to-date forms are always available on CSD's Providers' Website, to be accessed by network weatherization agencies only. (On the "Energy" tab, click on "Forms".) Agencies shall be responsible for distributing the current forms to their subcontractors.

2. Test Types and What Triggers Them

The following categories of Combustion Appliance Safety (CAS) testing are required:

- Pre-CAS Testing: As part of the home assessment, before any measure installation work is performed. The pre-CAS test procedure is required to be performed by the Assessor.
- Appliance R&R-CAS Testing: After combustion appliances are repaired or replaced.
- Interim CAS Testing: During installation of infiltration-reduction measures when work is not completed at the end of the day, an "interim" test is performed before the crew leaves the job site.
- Post-CAS Testing: As a final step to weatherization, after installation of infiltration-reduction measures is complete, to ensure that the appliances are left in safe condition.

All CAS testing and documentation of results shall be in accordance with the CSD 700 form series and this appendix.

2.1 PRE-CAS TEST (PERFORMED DURING HOME ASSESSMENT)

Pre-CAS testing shall be performed by qualified weatherization Agency technicians. Pre-CAS tests are valid for 60 days. After that, the test shall be repeated before any installation of infiltration-reduction measures.

When contacted by a client for ECIP EHCS services, the appliance must be pre-combustion appliance safety-tested to determine the scope of the appliance issue(s) and identify all hazardous and non-hazardous conditions pertaining to the appliance before any repair or replacement work will be completed.

2.2 INTERIM-CAS TEST

"Interim"-CAS testing shall be performed each day that "significant" air sealing (as described in the sidebar above) is performed but is not completed. Minimal testing is performed for each natural draft appliance that draws combustion air from the living space.

- Interim-CAS tests shall consist of all of the following:
  - Visual draft test ("Smoke" test), and
  - Tactile test for spillage

Interim-CAS testing shall be conducted with the house set up for appliance-on testing (exhaust devices on, and doors set properly), and the results shall be recorded on the CSD 700B or 702B Form.

INTERIM-CAS TESTING
is required when:

Blower Door is used, and:

- Any shell sealing was performed and the job was not completed the same day, OR
- Any amount of duct repair/sealing was performed.
- Mechanical Ventilation is installed.

Blower Door is not used, but one or more of these was installed:

- Duct repair/sealing.
- Any infiltration-reduction measures were installed and at least 10 sq. in. or more of leakage area was eliminated (total for all measures).
- Storm windows.

2.3 APPLIANCE R&R CAS TEST

All gas appliances that are repaired or replaced shall be checked for safe operation, following completion of any combustion appliance repair/replacement. This test shall be performed:

- The same day repair/replacement is finished, if feasible, but no later than 5 calendar days later.
- Before infiltration-reduction measures are installed.
- When appliance repair/replacement occurs as the target appliance for an ECIP EHCS job. When repair or replacement occurs after completion of infiltration-reduction measures, this test shall be attached to the CSD 57 ECIP Assessment Form.

2.4 POST-CAS TEST

Post-CAS testing shall be performed to prove that weatherization activities have not caused unsafe operation of natural draft appliances. Post-CAS testing is required the same day infiltration-reduction measures (including duct sealing) are completed, *and at least* one item in each of the next two "Conditions" exists (see blue box below):

POST-CAS TESTING *Condition 1:*

- The home has at least one open combustion natural or induced draft appliance that can be affected by changes to house pressure, including:
  - A FAU in any location, OR
  - A non-ducted heater or water heater that draws combustion air from the living space, or is located in an attached garage with or without a walk-through door into the living space.

POST-CAS TESTING *Condition 2:*

- Duct repair/sealing was performed.
- Mechanical ventilation was installed.
- Blower door was used and any shell sealing was performed.
- Blower door was not used, and installation of one or more of the following measures occurred:
  - Door or window replacement.
  - Storm windows.
  - Glass replacement.
  - Shell sealing, which eliminates holes totaling 10 sq. in. or more.
  - Door repair/modification (includes replacement of threshold or shoe, and repair/replacement of frame or stop).
  - Caulking that applied one or more tubes of caulk.
  - Range hood vent damper, fireplace chimney damper, or fireplace glass doors.
  - Interior vent cover(s).
  - Weatherstripping (door or non-door), including any of the following: entrance door, furnace enclosure door, patio door, attic or crawl space access, or windows.

If infiltration reduction measures were not installed, or if shell leakage was not reduced enough to justify a Post- CAS test, a Post-CAS test is not required.

3. Qualified Technicians

CAS Testing shall only be performed by technicians and service professionals who have successfully completed the required Combustion Appliance Safety training at a CSD-approved training center, or who have been provided equivalent permission by CSD. Testing shall be performed in accordance with the following policies:

- **Pre-CAS testing** shall be performed by the weatherization agency's technicians who have successfully completed Combustion Appliance Safety Training only.
- **Interim, Post Repair/Replacement, and Post-CAS tests** shall be performed by agency or subcontractor technicians who have successfully completed Combustion Appliance Safety Training or are trained HVAC subcontractors.
- **Fuel Oil Appliance Testing** shall consist of living space ambient testing by a qualified CAS testing technician. Further testing of the appliance and verification of the presence and operability of a draft regulator shall only be performed by a licensed professional contractor with appropriate training, or by a fuel oil supplier-qualified contractor.
- **CAS Hazards** (including gas leaks) shall be corrected by a qualified person, which in most cases is:
  - A utility gas service representative, when the appliance fuel is natural gas;
  - A licensed HVAC contractor (C-20) or licensed contractor-supervised technician;
  - A licensed plumbing contractor (C-36) or licensed contractor-supervised technician for water heaters;
  - A propane dealer's technician, for propane appliances.

Weatherization crews shall not make adjustments to the gas pressure, air-gas mixture, and other technical adjustments (unless fully licensed, trained, and authorized).

- Crews shall make only those CAS Fail repairs for which they are trained and qualified, which usually include:
  - Appliance abandonment, in compliance with CSD procedures.
  - Correction of draft hood abnormalities (e.g., improperly positioned, multiple, missing).
  - Vent pipe repairs (e.g., replacement, minor adjustments, securing single-wall metal vent pipe joints and connections with screws, vent caps, etc.).
  - Replacement of minor components (water heater burner access cover or inner shield, or furnace rollout shield). Component shall be factory-made, not field fabricated.
  - Clean greasy accumulations from gas cooking appliances, without affecting the combustion air adjustment.
  - Install additional, or correct nonconforming, CVA venting.
  - Install a clothes dryer moisture exhaust.

If any CAS testing reveals a CAS Hazard or a CAS Fail, correction timelines and procedures shall be followed in Section 5.2.

4. Required Test Equipment and Accessories

For specifications on test equipment, accessories, and tools, see the table below.

Materials	*Requirements*
CO ANALYZERS	- Carbon Monoxide Testers • Shall be manufactured under an ISO 9001 quality management system or be ISO 9001–certified • Shall, at a minimum, measure CO levels from zero ppm to 999 ppm • New Units: Capable of providing air-free CO readings • New and Existing Units: On-board or in-line NOx filter and condensate trap  *Overall Photo Credit:*
CO ANALYZER SAFETY TEST ACCESSORIES	- Safety Test Accessories • Monoxor Probe Extension materials: – 1/4" OD aluminum tubing (e.g., pilot tubing), cut in 1' & 2' (or longer) lengths (do not buy copper tubing) – 1/4" ID and 5/16" ID plastic tubing – Small stainless worm-drive clamp to fit over 5/16" ID plastic tubing • High-temperature caulk: Non-hardening sealant (e.g., RTV silicone) with a minimum service temperature of 450°F • Aluminum foil tape: UL-listed, with minimum service temperature of 265°F (e.g., 181A-P duct tape) • Liquid gas leak detection compound with spray bottle: can be "neutral" leak detection soap (not dishwashing detergent) • Incense sticks: mildest scent available • Smoke Sticks, Puffers, Pens to create smoke for diagnostic testing: commercially available • Match Extender: Alligator clip on telescoping handle
OTHER TEST EQUIPMENT	- Draft Gauges • Draft gauges shall have a range of –0.25 to +0.05 inches of water column (IWC), or –62.5 to +12.5 Pascals (Pa) - Thermometers • Thermometers shall have a range from 0°F to 250°F - Gas Leak Detectors • Gas Leak Detectors shall be listed to UL 913
PLUG BUTTONS	- Vent "Plug Buttons" • Metal and non-corrosive (e.g., nickel plated snap-in hole caps), sized to match drill bit(s) used to drill sampling holes (e.g., 5/16" and 3/8")

Materials	*Requirements*
SAFETY TEST TOOLS	- Safety Test Tools • Battery-powered nut driver, heavy duty, with 1/4" and 5/16" Magnetic Hex Nut Driver Bits • 5/16" and 3/8" Drill Bits: Metal drills sized to match plug buttons • Inspection Mirror: Small round or rectangular mirror on telescoping handle • Propane Lighter: "Gas Match" type trigger-operated, long-nose lighter (flexible nose is best)

The following guidelines for the creation of "probe extensions" used to measure CO in difficult-to-access locations. **THESE EXTENDERS SHALL BE ALLOWED UNLESS PROHIBITED BY THE MANUFACTURER OF THE TEST EQUIPMENT.**

4.1 PROBE EXTENSIONS

A probe extension ("extender") shall be used as needed to take "Air-Free" CO measurements in locations where a straight probe cannot achieve that result, such as:

- Natural draft water heater, to reach down into the center tube to measure CO on each side of the baffle.
- Natural draft wall furnace, to reach down into the flue (exhaust port) to measure CO on each side of the baffle.
- Closed combustion/direct vent units, to reach inside the flue to measure CO inside the exhaust stream.

4.2 ACCEPTABLE MATERIALS, CUTTING, AND BENDING

Extenders are made with aluminum tubing and clear plastic tubing. (Do not use copper tubing, because it may react chemically when exposed to flue gases). The extender is connected to the tester probe with clear plastic tubing, approx. 1 foot long.

- Required materials are found in hardware and auto parts stores (e.g., clear plastic tubing, aluminum tubing, and worm-drive clamps), and at gas appliance parts houses (e.g., 1/4" pilot tubing).
- The end of the extender shall be bent sufficiently to reach inside the flue to measure CO free of outside air:
  - A "standard" extender is about 1 foot long. For mobile homes, a 4' to 8' long extension may be needed to reach FAU flue terminations (usually several feet from the roof edge).
  - For aluminum extensions, 1" to 2" of tubing is bent at one end approximately 90° to form an "L" shape.

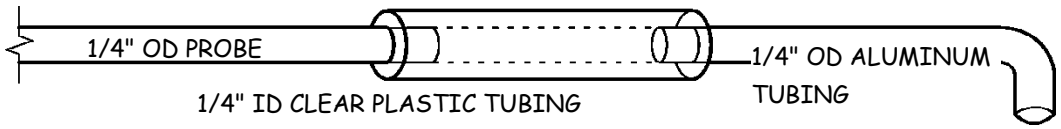
4.3 EXTENDERS FOR 1/4" OD PROBES (E.G., FOR MONOXORS)

To make an extender, use aluminum tubing, 1/4" OD (Outside Diameter). OD of the aluminum extender should match the OD of the CO Tester rigid metal probe, and the clear plastic tubing should fit securely onto both of them without clamps.

- The extender is made with 1/4" OD tubing, so it will fit into a standard 5/16" sampling hole.

Generally, the clear plastic tubing will be 1/4" ID (Inside Diameter). When selecting plastic tubing, have available both the aluminum tubing and CO Tester Probe. 1/4" ID plastic tubing should fit, but check because brands vary.

- Slide the plastic tubing over both the Tester Probe and aluminum extender. Plastic tubing must fit snugly but easily be twisted on/off the CO Tester Probe.
- Note: Some older CO Testers (e.g., early Monoxor II) have a *removable* metal Probe. The 1/4" OD aluminum extender can fit directly into the handle (plastic tubing not needed).
- Be careful to not lose or damage the small plastic ferrule inside, when installing and removing the aluminum extender directly into the CO Tester probe handle.

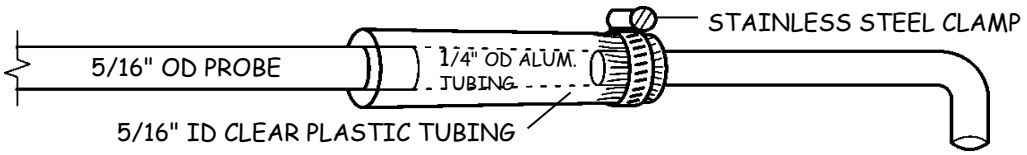


Graphic Credit: RHA, Inc.

4.4 EXTENDERS FOR 5/16" OD PROBES (E.G., ON FYRITE PRO)

Some CO testers have a 5/16" OD metal Probe, so larger ID clear plastic tubing is required. When selecting tubing, slip it over the probe to find a diameter that is removable but not loose.

- Keep aluminum extender tubing at 1/4" OD, so it will fit into a standard 5/16" sampling hole (eliminating the need for larger holes and larger plug buttons).
- Because the plastic tubing ID is larger than the OD of the aluminum extender, use a small stainless steel worm-drive clamp to secure the plastic tubing to the extender. (Do not clamp plastic tubing to the CO tester so it can be easily removed from the probe.



Graphic Credit: RHA, Inc.

4.5 CALIBRATION FOR CO TEST INSTRUMENTS

Carbon monoxide test instruments shall be equipped with a NOx filter (and condensate trap) and shall be properly maintained and calibrated in accordance with manufacturer's specifications and the following policies:

4.5.1 CALIBRATION TIMELINE

Each CO test instrument shall be calibrated:

- Every 6 months, or at intervals recommended by the manufacturer, if more stringent.
- After the instrument has been dropped or otherwise damaged.
- After the instrument has been subjected to several doses of high CO (1,000 PPM or higher), or
- Readings appear to be abnormal.

4.5.2 CALIBRATION LIMITATIONS

When dropped or otherwise damaged, an instrument must be calibrated and checked by an in-house qualified technician. (Note: When in-house calibration does not resolve all performance issues, instruments must be sent to a factory-authorized service center and replaced when recommended by the manufacturer.)

4.5.3 CALIBRATION REQUIREMENTS

- When the weatherization contractor has a calibration kit CO sensor calibration may be performed in-house, but only by qualified personnel trained to do so.
  - Calibration gas shall be maximum 500 PPM CO.
  - Instruments with an O2 sensor (e.g., those capable of "air-free" CO readings) must be calibrated by a factory-authorized facility.
  - A calibration label shall be applied to the instrument showing the technician's name, date, and PPM of calibration gas used.
  - Calibration information must be documented in the company's Calibration Logs (CSD 785 for "Carbon Monoxide Analyzers" and CSD 786 for "Manometers").

4.6 NOX FILTER AND CONDENSATE TRAP

A NOx filter and condensate trap are required to filter nitrogen oxides (NOx) from the flue gas, because NOx affects the CO sensor the same as CO does (it looks like CO). The NOx filter can be on-board (common in newer CO testers), or in-line (required for most older instruments). The condensate trap, usually clear plastic, is normally installed in-line.

Agencies and their subcontractors are required to obtain and install NOx Filters and condensate traps for older equipment, and to ensure that all new equipment contains these components for the following reasons:

- By removing NOx from the flue gases drawn into the CO tester, measurement accuracy is improved 50% to 75% or more. For example, the tester might read 120 ppm CO without a filter (appliance fails), but might more accurately read 60 ppm CO with a NOx filter (appliance passes).
- Without the filter, the appliance appears to need service. With the NOx filter, the appliance would Pass, and an unnecessary service call would be avoided.
- The condensate trap collects moisture from the flue gases, and prevents it from damaging the NOx filter and CO sensor.
- NOx filters shall be replaced in accordance with manufacturer's recommendations.

Graphic Credit: Bacharach, Inc.

5. CAS Testing Policies

5.1 REQUIRED ACTIONS FOR A CAS HAZARD OR CAS FAIL

CSD believes that Combustion Appliance Safety is the most critical of procedures that is undertaken by weatherization field personnel to ensure the safety of dwelling occupants. When an appliance does not operate properly, it can create a life-threatening condition such as Carbon Monoxide (CO). For this reason, whenever a CAS Hazard or CAS Fail is found for an appliance affecting the living space, corrective action by a qualified technician is required.

Agencies and subcontractors must mitigate and correct CAS Hazards, CAS Fails, and IAQ Fails that are within program scope before any other measures are installed. For DOE jobs, the client shall be notified in writing the results of fuel leak testing and the specific location(s) where the fuel leak is detected.

When a **CAS Hazard** or **CAS Fail** cannot be corrected, or correction would be outside of the scope of the program, CSD requires the following actions:

1. A program waiver shall be sought to bring the issue to CSD's attention.
2. The client must be notified, in writing, on the CSD 542 Deferral Form, a client signature obtained to confirm understanding of the issue, and a copy of the form shall be maintained in the client file.
3. (DOE) When the dwelling is served under DOE, or is leveraged with DOE, if a combustion appliance cannot be repaired or replaced within the program scope, written permission will be obtained from the client for the removal of the appliance. If removal is not allowed, the dwelling shall be a full deferral.
4. (LIHEAP) The issue shall be mitigated (appliance abandonment), a limited deferral is required, and the dwelling shall be NIM until the issue can be completely resolved.

5.2 TIMELINE FOR CORRECTION OF CAS HAZARDS AND CAS FAILS

Agencies are under a strict timeline to mitigate all CAS Hazards and CAS Fails as soon as they are identified.

CAS Hazards: Immediate hazards must be mitigated within 18 hours, even if infiltration-reduction measures will *not* be installed for any reason. Clients must be informed of the unsafe condition, the immediate plan to correct the issue, and precautions they must take, pending correction. If the CAS Hazard is corrected through temporary abandonment to mitigate the immediate hazard and a portable heating or cooling appliance was offered (as applicable), CSD considers the issue from that point on to be non-hazardous, and subject to the CAS Fail timeline described in the bullet below.

- Exception: If a water heater is temporarily abandoned to mitigate a hazard, the appliance condition must be completely resolved within five working days.

CAS Fails: Fails are combustion appliance safety conditions that must be corrected, but do not present an immediate threat to the occupants. All non-hazardous conditions noted field personnel shall be corrected within 20 working days of written notification by the Assessor/Auditor in the CSD 540 form. When a **CAS Fail** is found, the client must be advised of the issue, and provided with a timeline for correction. No infiltration-reduction measures shall be installed until after the fail is corrected.

The time periods for correction may be extended for circumstances beyond the agency's control; however, a waiver must be approved in writing by CSD prior to the expiration of the original timeline.

CAS Hazards and CAS Fails are sometimes referred to as "hazardous or dangerous conditions" while talking in the office. However, the term "hazard" should never be used when speaking with clients or occupants. Tell them the appliance "does not meet program safety standards, and an immediate follow-up service call is being requested".

5.3 APPLIANCE REPAIR VS. REPLACEMENT

A malfunctioning combustion appliance shall be examined by a qualified technician to determine Repair feasibility. Repair by a qualified technician shall be made, if feasible. Appliance replacements shall be made in conformance with the measure-specific policies of the CSD TRM and when repairs would equal more than 50% of the replacement cost. When appliance replacement is specified, and Manual J sizing documentation is required by Title 24, copies of the Manual J documents are required to be kept in the client file.

- To be replaced, an appliance must be documented to be unsafe and non-repairable (repair not feasible or not possible). That includes:
  - Evidence of unsafe condition(s) recorded in the CSD 700, and
  - Documented information from the qualified technician describing the issues and why the appliance cannot feasibly be repaired (such as defects too extensive to repair, or required parts are not available).

5.3.1 REPAIR EXCEPTIONS

- FVIR (Flammable Vapor Ignition Resistant) Water Heaters: If the FVIR System has been activated, the entire water heater must be replaced (cannot be repaired).
- Other repair exceptions will be considered by CSD on a case-by-case basis.

5.4 RESOLUTION OF CAS HAZARDS AND FAILS

By CSD policy, every effort shall be made (and documented) to correct an appliance Hazard or Fail that is within the program scope. When a CAS Hazard or Fail exists that is correctable, these policies shall apply:

- All CAS Hazards, CAS Fails, and IAQ Fails must be correctable and remedied before infiltration-reduction measures will be installed. If correction is NOT feasible within the program scope, see Section 5.1.
- Agencies and subcontractors shall not install infiltration-reduction measures when there is a possibility that a CAS Hazard, CAS Fail, or IAQ Fail cannot be corrected.

- Once identified by field personnel, the policies in the CSD TRM that regulate timelines for correction and feasibility of measures shall apply.

5.5 INACCESSIBLE APPLIANCES

When a gas appliance affects the living space, but cannot be tested because it is not accessible, the unit is considered a **CAS Fail**. The home shall remain deferred (DOE) or NIM (LIHEAP) unless it can and will be abandoned with owner permission on the CSD 542 Deferral Form.

5.6 INOPERABLE ("NON-OP") APPLIANCES

When the inoperable unit is a primary Health and Safety appliance, the unit is considered a **CAS Fail**. When a gas appliance potentially affects the living space, but is inoperable, a qualified technician shall attempt repair of the appliance when allowed under the program. If the technician documents that full repair or replacement is unfeasible, the home remains deferred (DOE) or NIM (LIHEAP) and the condition shall be documented on the CSD 542 Deferral Form.

5.7 APPLIANCE ABANDONMENT

For the CSD Weatherization Assistance Program (where DOE funding is used), appliance abandonment is not allowed for primary heat sources. The appliance must be repaired/replaced, or the dwelling must be deferred. Unsafe secondary heat sources must be repaired (except for portable heat sources) or removed. In mobile homes, any other type of combustion appliance that is unsafe must be removed from the dwelling with client permission on the CSD 540 Dwelling Assessment Form. If the client does not allow removal, the dwelling must be deferred.

When allowed under the LIHEAP weatherization program only, an appliance abandonment may be performed when a CAS Hazard or CAS Fail cannot be corrected within the scope of the program (i.e., appliances cannot be repaired or replaced, or for appliances the owner or occupant prefers to stop using). Abandonment may only be performed by a qualified crew person who is trained and authorized to do this work with permission from the owner and signature documented on the CSD 540. Abandonment shall be:

- When an essential appliance (e.g., primary heat source, water heater) is properly abandoned in accordance with the CSD TRM Appendix A, the dwelling shall no longer be NIM because the appliance shall no longer be considered an unresolvable CAS Hazard or CAS Fail.
- If a non-essential appliance has a Hazard or Fail condition that cannot be corrected under the program scope (e.g., a gas dryer, secondary heat source, portable heater, etc.), then the appliance may be abandoned with client permission. Once abandoned, the dwelling is no longer NIM.
- Abandonment, and the rationale for it, shall be documented on the CSD 542 Deferral Form, and a note made on the CSD 700.
- When prescribed, abandonment shall be completed before any infiltration or non-infiltration measures are installed.

Appliances shall not be abandoned solely to install infiltration-reduction measures. Every effort shall be made to repair or replace the defective appliance as a "Health and Safety" or "Energy Efficiency Upgrade" measure, when allowed by contract.

Client refusal to have a functioning primary heat and/or cooling source shall disallow installation of all infiltration-reduction measures in a dwelling.

APPLIANCE ABANDONMENT PROTOCOL

An appliance is considered abandoned only if the:

- The flexible gas connector is *removed*, and
- Appliance line (shutoff) valve is capped, or the valve is removed and the gas line is capped.
- Turn off power to the unit when applicable, by unplugging it or turning off the source (breaker or fuse).
- When a cooktop or oven burner is abandoned, the burner valve must be capped when possible.

In order for an appliance to be properly "abandoned", agencies or their subcontractors shall ensure that:

- Owners shall be informed of the reason for abandonment, options available, and the consequences of abandoning the appliance. Written permission must be obtained before an appliance is abandoned and documented in the CSD 540.
- If an appliance was removed from use by the owner or occupant prior to weatherization, the contractor shall ensure that the appliance has been "properly" abandoned (as described above), with documented written permission from the owner before any further weatherization activity is allowed.

5.7.1 PARTIAL ABANDONMENT

Partial abandonment may be an acceptable option for a malfunctioning cooktop so that a home is not NIM unnecessarily. For a cooktop or freestanding range, partial abandonment of up to 2 burner(s) or separate built-in oven is allowed when necessary and feasible.

- To abandon a burner, the burner valve must be capped. *Exception*: Capping is not required, and the burner is considered "properly abandoned", when:
  - The burner is non-operational (valve is frozen and the burner cannot be turned on and lit with a match), and
  - Capping the valve is not feasible/possible, and
  - There is no gas leak associated with the burner.

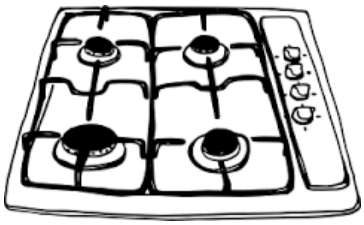


Photo Credit: Public Domain

Note: Only a check for gas leaks is required for abandoned burners—however, a complete CAS inspection and test is required for the working cooking appliance components (e.g., other burners, oven, and broiler).

6. Descriptions of Abnormal Findings (Fails)

The following section describes typical CAS-identified conditions that may be encountered in the field. Depending upon whether it is a CAS Hazard or a CAS Fail, CSD requires the correction of that condition. When other conditions are encountered, and there is uncertainty about how to handle a situation (i.e., whether it is a hazard or not), agencies and their subcontractors shall communicate with the CSD Technical Hotline at (877) 831-7596 or Wx.Hotline@csd.ca.gov.

6.1 CAS CONDITIONS AND RESPONSES

While assessing client homes, the discovery of any abnormal finding during the Pre-CAS test begins a timeline of correction for agencies or their subcontractors as defined in Section 5.2. These abnormal findings are most commonly called **CAS Hazards** and **CAS Fails**. When a non-conforming condition is found that does not prevent weatherization, it is now known as an **Advisory Condition**.

6.2 ADVISORY CONDITIONS

In a home assessment, certain non-conforming conditions do not create an immediate health and safety hazard, but are required to be brought to the attention of the client. Repair of these items shall not be performed. These conditions do not prevent duct or shell sealing.

TABLE 6.2: EXAMPLES OF ADVISORY CONDITIONS

ADVISORY CONDITIONS DO NOT IMPEDE WEATHERIZATION.

- Inadequate clearance of vent pipe to combustibles.
- When an appliance or vent system will not be replaced, and no charring is evident, a single-wall vent pipe where B-vent is required, and/or no firestop spacer, support box, or thimble at ceiling or wall penetration.
- Vent pipe is transite (asbestos-containing) material.
- Nonconforming appliances that do not affect the living space.
- Horizontal vent pipe run without adequate upward slope, but draft is satisfactory.
- Propane tank is inadequate distance from dwelling.
- Cook stove defects, as described below:
- A pilot does not work, but the burner can be lit with a match, it burns properly. CO must be below the Action Level.
- A burner knob is frozen.
- 1 or 2 cook top burners will not light, even with a match.
- The oven operates but has a separate broiler burner that does not work.

Photo Credit: Community Resource Project

6.3 CAS HAZARDS

CAS Hazards are conditions that cause immediate danger to the client. The hazardous condition(s) must be corrected within 18 hours, even if infiltration-reduction measures will not be installed for any reason. Clients must be informed of the unsafe condition and kept safe while it is being corrected. Some examples of **CAS Hazards** are provided in Table 6.3 below.

Photo Credit: WAPTAC.org

TABLE 6.3: EXAMPLES OF HAZARDOUS CONDITIONS

CAS HAZARDS MUST BE REMEDIED WITHIN 18 HOURS.

- Gas leak.
  - Note: If a gas leak is found in a location with a soldered or copper connector, the connector shall be replaced as part of the hazard correction.
- CO PPM above the "Action Level" (also called "high CO").
- Delayed ignition with high CO.
- Portable propane tank is used in a dwelling to fuel a dwelling appliance(s) such as a cooking appliance or water heater, or has inadequate clearance from dwelling (requires immediate home Deferral).
- There is a known code violation or obvious unsafe condition with a kerosene heater or kerosene storage tank (requires immediate home Deferral), such as:
  - The storage tank is too close to a heat source.
  - The storage tank or fuel line is leaking.
  - The storage tank is sagging, or any other aspect of the tank/installation is unsafe.
  - There is scorching of combustibles due to inadequate indoor clearance from the heater.
- Continuous roll-out: Fuel gas combustion process where flame extends outside the normal combustion area of a combustion appliance.
- Spillage or backdrafting: Continuous flow of combustion gases from a vented natural draft combustion appliance, where gases do not draft properly.
- Vent system obstructions that cause spillage.
- Flame interference (in a FAU): A change in flame pattern or color as the FAU blower comes on, usually indicates a defective heat exchanger. Look for evidence of a damaged exchanger with appliance off (crack or metal fatigue, visible with a mirror and strong light).
- Physical evidence of a defective heat exchanger (defects that create an actual high carbon monoxide condition, such as cracks, holes, warping, metal fatigue, etc.).
- Unsafe fuel modification (e.g., propane used in appliance with natural gas orifice).
- Damaged/disconnected vent pipe that allows CO to enter the home.
- Vent terminal is too close to an evaporative cooler during the cooling season.
- Return air system leaks that cause spillage and/or draw any combustion byproducts or toxic fumes into the duct system.
- Mobile home: Improper/failed isolation of return air in a mobile home (where a divided enclosure is shared by an FAU with non-ducted return intake and an open combustion water heater. This is referred to as improper isolation of return air, because the FAU return intake depressurizes the FAU side of the enclosure, and that can cause the water heater to backdraft and spill CO into the return air system.
- Any other condition that allows flue gas to enter a home.

When performing CAS testing procedures and a CAS Hazard is discovered:

1. Turn off appliance—at the wall thermostat, gas control valve, and the appliance line (shutoff) valve. If applicable, also unplug unit or turn off power at the breaker/fuse.
2. Inform occupants of the unsafe (nonconforming) condition, and advise them to not use that appliance until service has been performed and the condition has been corrected.
3. Record the condition in the CSD 700.
4. Document client notification, using the CSD 540 Assessment Form.
5. Mark the "Service Required" box on the CSD 700 and notify the agency immediately. Once a hazard is identified, agencies may not exceed 18 hours to mitigate the issue.
6. No measures (including infiltration-reduction measures) shall be installed before all **CAS Hazards** are corrected.
7. If correction is beyond the scope of the weatherization program:
   - A CSD 542 Deferral Form shall be completed, and
   - The client shall be referred to a program that may have repair or replacement service available to the household, such as ECIP EHCS.

6.4 CAS FAILS

CAS Fails are combustion appliance safety conditions that must be corrected within 20 business days of discovery, but do not present an immediate threat to the occupants. During a home assessment, any **CAS Fails** that are discovered must be recorded in the CSD 700, and the client shall be advised of:

- The condition and plans for correcting it.
- Precautions they should take, if any, pending the correction.

Photo Credit: WAPTAC.org

6.4.1 NATURAL GAS CAS FAIL

For natural gas appliances, if correction of an unsafe CAS condition is not within the scope of CSD programs, the appliance must be referred to the utility Gas Service Department (who may red-tag the appliance and shut it off).

6.4.2 PROPANE CAS FAIL

For propane appliances, a CAS fail referral would be to the propane provider.

- If the propane supplier does not take action to protect the health and safety of the occupants, the weatherization contractor shall do the following:
  - Notify the owner or rental manager and, if applicable, complete the CSD 542 Deferral Form for partial deferral (house shall be NIM, unless abandonment is allowed).
  - Request permission of the owner/rental manager to abandon the appliance (as described in Section 5.7).
- The agency shall take action as requested by the owner or rental manager; document all actions in the CSD 700, and proceed.

6.4.3 EXAMPLES OF CAS FAILS

Examples of CAS Fails are provided below:

TABLE 6.4.3: EXAMPLES OF CAS FAIL CONDITIONS

CAS FAILS TO BE CHECKED BY A QUALIFIED TECHNICIAN AND CORRECTED WITHIN 20 BUSINESS DAYS

ALL COMBUSTION APPLIANCE CAS FAILS

- Appliance enclosure floor or platform that is deteriorated or unsafe.
- Appliance enclosure door missing, when CVA comes from outdoors.
- CVA is inadequate/incorrect/obstructed.
- Excessive amounts of carbon or rust deposits are present on the appliance.
- Flame Abnormalities.
  - Improper flame position.
  - Soft lazy flame or smothering flame (flame recirculation).
  - Large yellow flame (unless that is normal for the appliance). Note: Some burners (e.g., in space heaters, decorative fireplaces, and gas logs) are designed to burn with a yellow flame. Service is not required if (a) the burner is normal per manufacturer's specifications, and (b) it is not producing excessive CO or soot (e.g., carbon in the combustion chamber and/or draft hood).
- Ignition Abnormalities.
  - Delayed ignition (with a bang or whoosh) with CO PPM below Action Level.
  - Pilot defects, such as IID (intermittent ignition device) do not properly light pilot or the thermocouple/ pilot generator does not function properly.
  - Roll-out ignition and scorching (not continuous roll-out).
- Physical evidence of a defective heat exchanger (defects that do NOT create an high carbon monoxide condition, such as warping or metal fatigue, etc.).
- Primary gas appliance (e.g. space heater, water heater, range) that will not operate, and there is no gas leak.
- Propane tank is connected to appliance with rubber tubing.
- Kerosene storage tank is against the wall and is in violation of local code (the home is NIM).
- Unsafe connector (see Section 7.3 for additional information)., such as:
  - Gas flex line with soldered fittings but no gas leak.
  - Copper tubing used as gas appliance connector.
- Inadequate clearance to combustibles causing visible evidence of a fire danger, including charring of wood, melting of foam insulation, etc.
- Vent defects.
  - Loose joints or connections needing screws, missing or defective vent caps, etc.
  - Improperly positioned draft hood, multiple draft hoods, or missing draft hood. (Note: spillage or high CO created by this condition is a CAS Hazard and must be corrected within 18 hours).
  - Vent terminal is too close to a window, door, or gravity inlet into the home.
  - Gas vent pipe is connected to a solid fuel chimney.
  - Vent cap is damaged or missing.

HEAT SOURCE CAS FAILS

- FAU "short cycling" on the limit switch.
- Return leaks inside the FAU enclosure, or anywhere combustion products can be drawn in.
- Recalled NOx rod furnaces (see Section 7.4 for additional information).
- Improper appliance modification, or missing or defective parts, such as the following:
  - Furnace combustion chamber door is defective or missing.
  - Furnace roll-out shield is defective or missing (if unit was manufactured with one).
  - Wall furnace front cover/grille is missing or damaged enough to make furnace unsafe.

- Furnace roll-out shield missing (if manufactured with one).
- Air Handler door defective or missing (opening must be temporarily sealed for testing). Note: This is a CAS Hazard when the FAU is natural draft, or a natural draft water heater is in the same enclosure.

WATER HEATER CAS FAILS

- Flammable Vapor Ignition Resistant (FVIR) water heater system that has been activated. When identified, the water heater shall be replaced (it cannot be repaired).
- Closed combustion or FVIR water heater, with combustion chamber access not securely closed and sealed.
- Open combustion water heater with both combustion chamber inner shield and outer door missing.

OTHER APPLIANCE CAS FAILS

- Gas range with three or more defective burners. (Note: A cooktop with up to 2 non-operational burners, is not a CAS Fail.)
- Gas clothes dryer in the living space with moisture exhaust not ducted outdoors.

MOBILE HOME CAS FAILS

- Mobile Home that has one or more of the following conditions:
  - Gas cooking, but gravity or mechanical ventilation not present.
  - Space heater, water heater, or solid fuel appliance is drawing combustion air from the living space, unless the CAZ is less negative than the HDL.

7. Special CAS Considerations

There are some unique combustion appliance conditions that require additional information in order to determine if a CAS Hazard or a CAS Fail may be present. The following sections are intended to provide supplement the knowledge of field technicians, and help them make more informed decisions.

Specifically, this section provides information about:

- Propane Conditions
- Kerosene Conditions
- Unsafe Connectors
- NOx Furnace Recalls

7.1 PROPANE (LP GAS) CONDITIONS

Regular propane tanks may <u>not</u> be within 10 feet of a building. Here is a summary of clearances typically applicable to weatherization situations:

Photo Credit: Public Domain

<u>Tanks Under 125 Gallons</u>

- Minimum 5' from doors, windows, and crawlspace vents.
- Minimum 10' from any combustion or ignition source, such as window/wall AC, central AC condenser, direct vent appliance terminal, open combustion appliance, or any open flame.

<u>Tanks 125 to 500 Gallons</u>

- Minimum 10' from doors, windows, and crawlspace vents.
- Minimum 10' from any combustion or ignition source, such as window/wall AC, central AC condenser, direct vent appliance terminal, open combustion appliance, or any open flame.

<u>Tanks More Than 500 Gallons</u>

- Minimum 25' from the building.

When a tank does not meet the correct clearance requirement, the property owner shall be notified of the nonconforming condition in writing as an Advisory Condition, but the home is <u>not</u> NIM.

IMPORTANT NOTE: Rubber tubing shall NEVER be used to connect the tank to the appliance. If rubber tubing is used, it is a **<u>CAS Fail</u>**.

PORTABLE PROPANE TANK WARNING

At the right is an example of a portable 5–10-gallon propane tank. Other types of portable tanks include smaller cylinders used for camping stoves.


Photo Credit: Public Domain

It is ***illegal and very unsafe*** to have a small propane cylinder inside a closed building (especially a dwelling). The regulator vents gas into the atmosphere, so indoors it would vent propane into the living space -- which, if ignited, could cause an explosion.

Therefore, when any propane tank is encountered *inside the home* to fuel an indoor appliance:

- CAS Testing shall NOT take place for any appliance.
- Raw propane fumes inside the home constitute an explosion hazard, and the weatherization contractor shall not install **ANY** measures.
- A Deferral Form <u>must</u> be completed to notify the occupants and owner that the condition is very unsafe and must be corrected before any weatherization services shall be provided. You must carefully list the conditions that have led to the home deferral on the Deferral Form and obtain the client's signature.

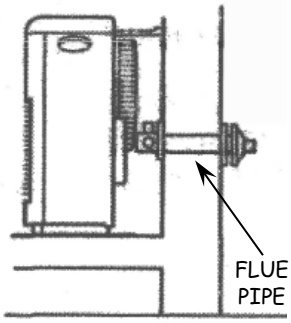
If a portable 5–10-gallon tank is properly set up outdoors (more than 5' from the building, doors, windows, and crawlspace vents), no gas leak exists, and the regulator and tubing are in good condition (also **NOT** rubber tubing), etc., then a CAS test may be conducted and weatherization work completed in accordance with programmatic policies.

If in doubt about whether a CAS test or weatherization work is feasible, call your supervisor for advice and assistance!

7.2 KEROSENE CONDITIONS

When a home is heated with a kerosene-burning appliance, check these conditions:

- Appliance Venting—does a flue pipe take combustion gases outdoors?
- Heater Location—is a heater located too close to combustibles? Is there scorching?
- Fuel Tank Location—is kerosene piped in from an unsafe outdoor storage tank?



EXAMPLE OF A DIRECT VENT KEROSENE HEATER

Graphic Credit: RHA, Inc.

Appliance Venting

- Some homes have code-conforming *vented* kerosene heaters (such as Monitor® and Toyotomi® models) that:
  - Are mounted on the floor near a wall, and
  - Have a "flue" pipe extending outdoors—usually through the wall (possibly through a window using a special window kit).
- These are usually direct vent (DV) appliances, with a double-chamber flue system that brings in combustion air through one chamber and exhausts combustion gases out through the other.
- A kerosene heater used for residential space heating must be vented outdoors. If not, it is an unvented heater, which is a **CAS Fail** and makes the home NIM.

Appliance Location

- Direct Vent kerosene space heaters can usually be located fairly close to combustibles. Clearances vary by make and model, so consult the installation manual. Check at the manufacturer's website, when possible.
- In the absense of instructions, the following default clearances from combustibles may be used (which may be greater than required by the manufacturer):
  ● Front = 5', ● Rear = 6", ● Sides = 1', ● Top = 2'
- Advise occupants when there is an inadequate clearance. If there is scorching of combustibles, see below.

Fuel Tank Location

- Manufacturer's Instructions: Manuals specify outdoor tank clearance from a "heat source"—which may be a combustion appliance burner, draft hood, or vent termination (including that of the kerosene heater).
  - Recommended clearances range from 3' (Monitor®) to 6' (Toyotomi®). Check the specific installation manual.
- National Standards: NFPA 31 allows location of a kerosene storage tank *adjacent to* a home, but it must not be too close to a heat source, and the tank and fuel line must not sag or leak.
- Local Code: The local building department and fire marshal interpret the safety codes regarding clearances, support, warning signs, etc.
  - A home is not NIM simply because an outdoor kerosene tank is adjacent to a wall.
  - When in doubt, the local jurisdiction can tell you if tank location or condition may be unsafe (or may be a code violation).

CHECK TANK AND PIPE FOR UNSAFE CONDITIONS

Photo Credit: © 2015 InspectAPedia.com

What to Do

- **Defer** the home when there is a known code violation or obvious unsafe condition and correction is outside the program scope, such as:
  - The storage tank is too close to a heat source.
  - The storage tank or fuel line is leaking.
  - The storage tank is sagging, or any other aspect of the tank/installation is unsafe.
  - There is scorching of combustibles due to inadequate indoor clearance from the heater.
- **Weatherize** the home. Install:
  - All measures, when the heater and storage tank do not appear to be unsafe or in violation of local code.
  - Non-infiltration measures, when storage tank against the wall is a violation of local code (home is NIM).

7.3 UNSAFE GAS CONNECTORS

Soldered Flexible Gas Connectors

Until about 1986, uncoated brass flexible gas connectors were made with one or both threaded fittings soldered onto the flex tubing ("butt-soldered" joints). Solder may react with gas and become weakened, causing the soldered joint to break loose when the connector is disturbed, and creating a catastrophic gas leak and potential explosion of gas ranges or clothes dryers.

Photo Credit: CROBERTS.com

- When checking for gas leaks in older homes:
  - Look for uncoated brass flexible gas connectors with either or both fittings soldered onto the flex tubing.
  - Use information and procedures on the next page to help with the identification and correction of soldered flexible gas connectors.
  - Resource: Consumer Product Safety Commission at http://www.cpsc.gov.
- If identified:
  - It is leaking gas, list as a **CAS Hazard** in the CSD 700. If natural gas, the utility shall be notified immediately. Turn off the *appliance line valve*. Do not attempt to tighten fittings. Correction within 24 hours is required.
  - If not leaking gas, list the connector as a CAS Fail in the CSD 700 and replace with a new listed connector, if qualified and authorized to do so.[1]
  - Do not bend or disturb the connector or fittings—and do not move the appliance.

Copper Tubing Used as a Gas Connector

Copper is no longer used; however, in some older installations, copper tubing was used to bring gas from the appliance line valve to the appliance. Copper reacts with gas, causing deterioration of the metal and sometimes blockage of the line.

- Replace the unsafe copper connector with a new listed connector, if qualified and authorized to do so (or have it done by a qualified technician).
- When checking for gas leaks in older homes: a copper connector is not a **CAS Hazard**, unless it is clogged or leaking.
- If identified:
  - If it is not clogged or leaking, list it in the CSD 700 as a CAS Fail.

When replacing an unsafe gas connector, it is best practice to replace the gas valve at the same time, especially "spring"-type gas valves.

[1] Contact the gas supplier to determine if they have a replacement program for soldered or copper tubing gas connectors (some utilities replace unsafe connectors at no charge).

– If it <u>is</u> clogged or leaking, it is a **<u>CAS Hazard</u>**. Document the issue in the CSD 700 and mitigate within 18 hours.

7.3.1 IDENTIFYING SOLDERED CONNECTORS

A flexible gas connector is considered unsafe and *must be replaced* with a new listed flexible gas connector when it is: **kinked, corroded, shows signs of visible wear, was manufactured <u>before</u> 1973** (per date ring near fitting), **or has any soldered connections.**

Protect your clients by correctly identifying and responding to soldered gas connectors:

1. **<u>All</u> soldered** flexible gas connectors are made of **uncoated brass**, and **must** be replaced.
2. **<u>Not</u> all uncoated brass connectors are soldered**, and if <u>not</u> soldered, replacement is <u>not</u> required.

Learn to recognize connections that are soldered…

IMPROPER BRASS FLEX CONNECTORS WITH <u>SOLDERED-ON</u> FITTING AND NO COATING

At the right is a **soldered** connector with corrugations right up to the fitting (soldered joint location).

Improper *(soldered) flex connectors:*
(a) are always brass color, ***<u>and</u>***
(b) have corrugations right up to the fitting, ***<u>or</u>***
(c) have a short sleeve covering the corrugations behind the fitting.

At the left is a **soldered** flex with a short sleeve covering the corrugations behind the fitting.

PROPER FLEX CONNECTOR WITH <u>SMOOTH NECK</u> AND GRAY COATING

Pictured to the right is an **acceptable** connector with a smooth neck entering the fitting (it may also be uncoated, plain brass).
Note that it has a *gray coating,* which <u>soldered</u> flex connectors do <u>not</u> have.

Proper *flex connectors:*
(a) may be brass <u>without</u> a gray or yellow coating, ***<u>or</u>***
(b) may be silver (stainless steel instead of brass), ***<u>and</u>***
(c) have a smooth neck between the corrugations and the fitting.

Graphic Credit for all photographs on this page: RHA, Inc.

If in doubt about whether a flex connector is soldered, call your supervisor for advice and assistance!

7.4 NOX FURNACE RECALLS

When performing CAS visual inspection of a horizontal furnace, it is important to determine whether it is one of the "NOx rod furnaces" subject to recall. These furnaces have potential fire hazards associated with the burner design. "NOx rod furnaces" were sold in California from January 1983 through December 1991.

- When checking horizontal furnaces:
  - Look for gas-fired horizontal units (like the pictures below) that are equipped with steel "NOx rods" installed above the burners. These units must be checked by a qualified technician.

Photo Credit: RHA, Inc.

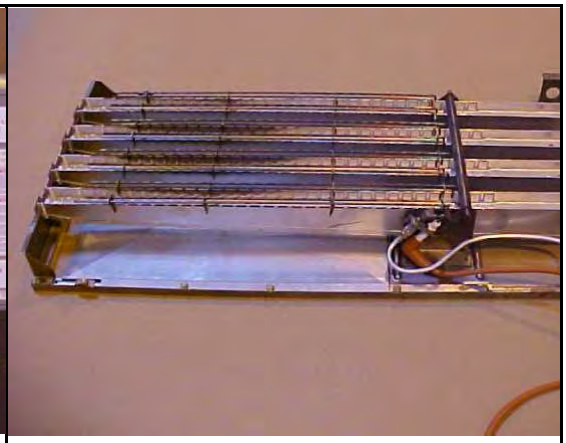


Photo Credit: RHA, Inc.

These gas-fired horizontal furnaces have steel "NOx rods" installed above the burners. The picture on the right has more detail.

- If identified:
  - Check the nameplate on each horizontal furnace to determine if it was manufactured before 1992. If it was (or you can't tell), check to see if the model number is one listed in Table 7.4.1.
  - Schedule the furnace for examination by a qualified technician when:
    - The furnace is on the recall list, or
    - The model number cannot be determined (e.g., missing or illegible), or
    - Visual inspection reveals NOx rods in the combustion chamber.
  - If the furnace is determined to be a "NOx Rod Furnace" subject to recall, then:
    - The furnace is a **CAS Fail** and must be replaced before infiltration reduction measures are installed. If the appliance is on the recall list but replacement is not feasible, infiltration-reduction measures shall not be installed.
    - When an identified recalled FAU is replaced by the manufacturer at no cost, the weatherization contractor shall be reimbursed only for costs actually incurred, generally limited to ancillary components and installation labor. Costs for the unit itself shall not be billed to the weatherization program when the unit is replaced by the manufacturer.

TABLE 7.4.1: LIST OF NOX ROD FURNACES RECALLED MODELS

COMPANY NAME	TRADE NAME	"NOx Rod Furnace" MODEL NUMBERS
Addison Products Co.	**Weatherking**	GHC
Amana Company	**Amana**	GSE50DN3X, GSE75DN3X, GSE100DN5X
Arco Comfort Products	**ACP, Arcoaire, Northrup**	GHB
Bard Manufacturing	**Bard**	ESG040D36B, ESG040D36BC, ESG050D36B, ESG050D36BC, ESG060D36B, ESG060D36BC, ESG060D48B, ESG060D48BC, ESG080D60B, ESG080D60BC, ESG100D60B, ESG100D60BC, ESG120D60B, ESG120D60BC, ESG140D60B, ESG140D60BC, ESG050D36D, ESG060D48D, ESG075D48D, ESG080D60D, ESG100D60D, ISG060D36AX, ISG080D48AX, ISG100D60AX, ISG120D60AX
Carrier Corporation	**Sunburst by Carrier Southern California**	HAC040N(D,E, or F)3RXC, HAC050N(D,E, or F)5RXC, HAC050ND3RXD, HAC060N(D,E, or F)4RXC, HAC075N(D,E, or F)4RXC, HAC080N(D, E, or F)5RXC, HAC100N(D, E, or F)5RXC
Climate Control	**Climate Control**	GHC
Coleman Company (Evcon Industries)	**Coleman**	2505-25090B/ 2505-2509C, BGH
Consolidated Industries	**Consolidated**	HAC/HCC, HBA
DMO Industries	**Duomatic-Olsen, Olsen, Airco**	HCC, HBA
Goettl Air Conditioning, Inc.	**American Best, Goettl**	HAC040N(D, E, or F)3RCX, HAC050N(D, E, or F)3RCX, HAC040N(D, E, or F)3RXD, HAC050N(D, E, or F)3RXD, HAC040N(D, E, or F)3RXC, HAC050N(D, E, or F)3RXC, HAC060N(D, E, or F)4RXC, HAC075N(D, E, or F)4RXC, HAC080N(D, E, or F)5RXC, HAC100N(D, E, or F)5RXC, HCC040N(D, E, or F)3RX, HCC050N(D, E, or F)3RX, HCC060N(D, E, or F)4RX, HCC075N(D, E, or F)4RX, HCC100N(D, E, or F)5RX, HBA040N(D, E, or F)3RX, HBA060N(D, E, or F)3RX, HBA080N(D, E, or F)4RX, HBA100N(D, E, or F)5RX, HBA120N(D, E, or F)5RX

COMPANY NAME	TRADE NAME	"NOx Rod Furnace" MODEL NUMBERS
Goodman Manufacturing Company	**Franklin Electric, Goodman, GMC, Hamilton Electric, Janitrol, Johnstone, Liberty**	HBA040ND3(X, RX, XC or RXC), HBA060ND3(X, RX, XC or RXC), HBA080ND4(X, RX, XC or RXC), HBA100ND5(X, RX, XC or RXC), HBA120ND5(X, RX, XC or RXC), HCA040ND3(X, RX, XC or RXC), HCA060ND3(X, RX, XC or RXC), HCA080ND4(X, RX, XC or RXC), HCA100ND5(X, RX, XC or RXC), HCA120ND5(X, RX, XC or RXC), HCA140ND5(X, RX, XC or RXC), HCC040ND3(X, RX, XC or RXC), HCC050ND3(X, RX, XC or RXC), HCC060ND4(X, RX, XC or RXC), HCC075ND4(X, RX, XC or RXC), HCC080ND5(X, RX, XC or RXC), HCC100ND5(X, RX, XC or RXC)
Heat Controller, Inc.	**Comfort-Aire**	GSH40-T3N-X, GSH50-T3N-X, GSH60-T4N-X, GSH75-T4N-X, GSH80-T5N-X, GSH100-T5N-X
ICG/Keeprite	**Keeprite**	HAC/HCC, HBA
Johnson Supply	**Air Star**	SGH
Magic Chef Air Conditioning	**Magic Chef**	EG, ENG
MLX Refrigeration and Air Conditioning	**Heatmaster**	HAC/HCC, HBA
Premier Furnace Company	**Premier, Sunburst, Sun Glow, PFC, Carrier, Sunbelt**	HAC/HCC, HBA
Sears	**Kenmore**	735
Square D Company	**Sundial**	GH
The Trane Company	**Trane (XE60, XE70, XL80), American Standard**	THN050A936A, THN060A948A, THN075A948A, THN100A960A; also THS and THD
Westbrook Distributing, Inc.	**Heatmaster**	HAC/HCC
Any company	**Any brand**	HAC/HCC

Additional information may be obtained online at the following websites:

- FAQ website: http://www.furnaceinspect.com/questions.shtml#1
- CPSC recall list: http://www.cpsc.gov/cpscpub/prerel/prhtml01/01189.html
- Fire Marshal's recall list: http://www.furnaceinspect.com/includedmain.shtml

If in doubt about whether a horizontal FAU is a NOx rod unit, call your supervisor for advice and assistance!

8. Basic CAS Testing Procedure

For each combustion appliance affecting the living space, the following tests are required:

- Gas leak check.
- Visual inspection of appliance and vent system.
- CVA (combustion ventilation air) evaluation.
- Living space ambient carbon monoxide (CO) reading
- Appliance Ambient CO reading.
- Flue gas CO reading.
- Draft test of the appliance.
- Combustion appliance zone (CAZ) test, when applicable.

For each combustion appliance not affecting the living space, the following tests are required:

- Gas leak check.
- Visual inspection of appliance and vent system.

In CSD's weatherization program, the minimum CAS test procedure is made up of eight (8) steps, and is repeated for both pre- and post-tests. These 8 steps are repeated to test all types of combustion appliances.

8.1 STEP ONE: GAS LEAK CHECK

The gas leak check is the first test done during the home assessment, and it is the first step in all CAS testing to ensure that the combustion appliances in the home are not leaking gas. It is required that all combustion appliances be checked for leaks first, because if a leak is found, the CAS testing procedure must **STOP** immediately. Once the gas leak check is complete for all appliances, the additional steps (2-8) are repeated at each appliance.

8.2 STEP TWO: VISUAL INSPECTION

If no gas leaks are present (or identified leaks have been repaired), the CAS procedure continues with the 2nd step—the visual inspection, which includes identification of:

- Appliance inaccessibility;
- Unvented heating systems, including use of cooking appliances to warm the home;
- Unsafe gas connectors;
- Vent, draft hood, and vent system abnormalities;
- Heat exchanger defects; and
- Lack of appliance safety features (such as combustion chamber cover or shield) and improper alterations.

8.3 STEP THREE: CVA (COMBUSTION VENTILATION AIR) EVALUATION

This step determines if each appliance has enough fresh air to operate properly in the room or enclosure where it is located. The assessor will evaluate CVA for each appliance and provide this information to crews on the CSD 700 or 702 Form when additional combustion and ventilation air is needed.

8.4 STEP FOUR: LIVING SPACE AMBIENT CO READING

Next, two ambient carbon monoxide (CO) readings are taken in the living space. This test is used to determine if the home, with the normal operating state of the space heating appliance(s), has excessive CO present in the living space.

8.5 STEP FIVE: APPLIANCE AMBIENT CO READING

Immediately after the second Living Space Ambient CO reading is taken, the Appliance Ambient CO reading is taken for the space heating and water heating appliances(s), to ensure that the appliances are not sending CO into the living space.

8.6 STEP SIX: FLUE GAS CO TEST

The flue gas CO test determines whether or not the amount of CO carried in the appliance vent is within acceptable limits.

Note: When a flue gas CO test is not feasible (i.e., test location is inaccessible) or is not possible because of the type of appliance, an Appliance Ambient CO test is substituted. Check Section 13 for a description of the required procedures.

8.7 STEP SEVEN: APPLIANCE DRAFT TEST AND SPILLAGE CHECK

The appliance Draft Test and Spillage Check is a two-stage process:

- First, a Draft Test is conducted to determine whether negative pressure in the vent pipe is adequate for proper exhaust of combustion gasses up through the vent system.
- Then, the appliance is checked at the draft hood for evidence of "spillage"—which is escape/outflow of combustion gases from the draft hood opening (because gasses are not exiting the vent pipe as they should).

8.8 STEP EIGHT: COMBUSTION APPLIANCE ZONE (CAZ) "WORST CASE" TESTS

When an open combustion natural draft appliance is located inside a living space, a CAZ Test must be performed to determine whether exhaust devices or duct system imbalance are causing the combustion appliance zone to become overly depressurized. This can cause appliances to draft poorly or "backdraft", which is a dangerous condition.

CAZ testing is used to find and correct room-to-room imbalances, and make sure that a home is not brought below the House Depressurization Limit (HDL). CAZ testing is required for the following appliances and building types:

- Conventional Homes: A solid-fuel combustion appliance drawing combustion air from indoors.

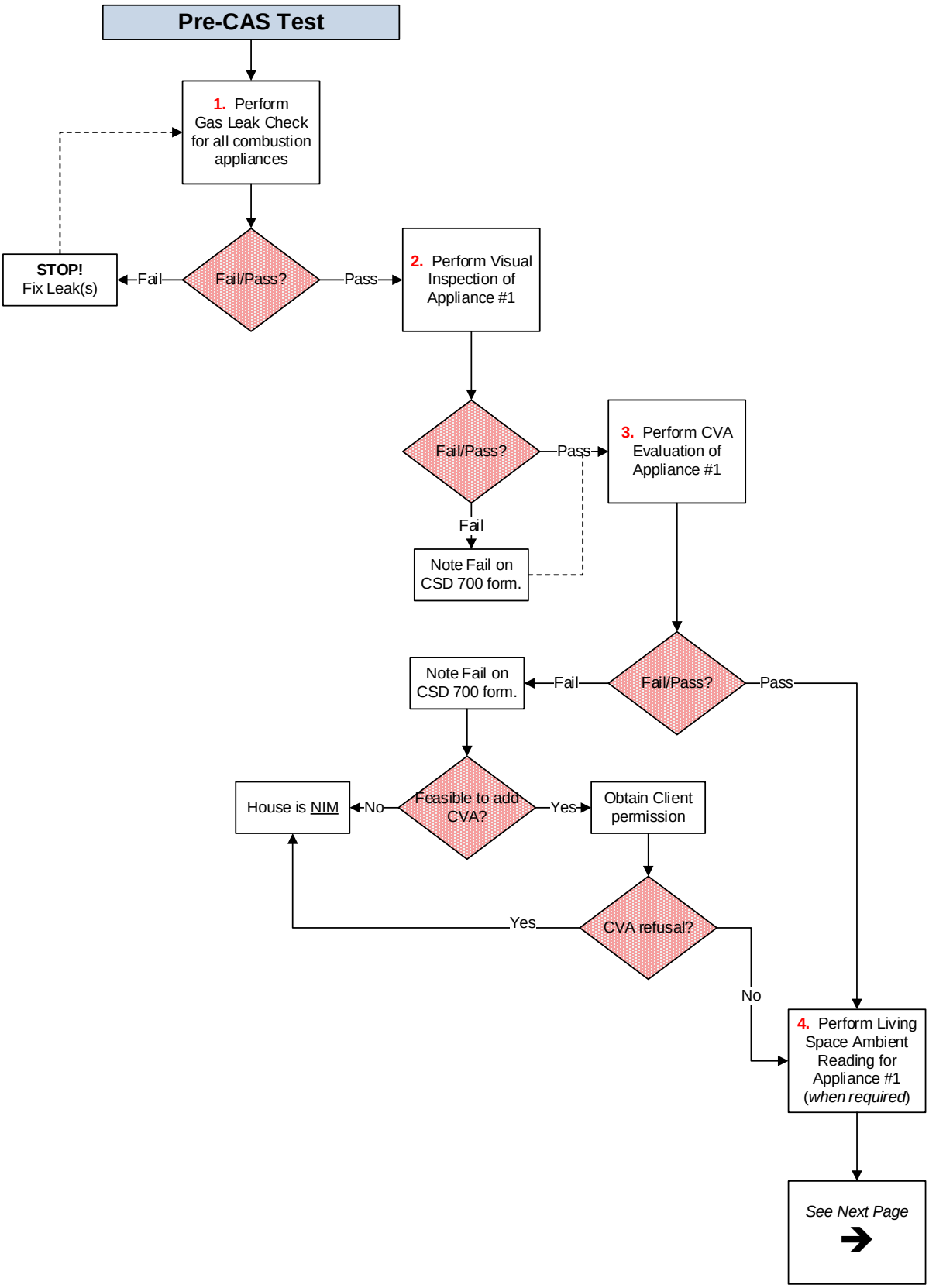
- Mobile Homes: CAZ testing is required when combustion air is drawn from the living space by any of the following appliances:
  - an open combustion space heater, or
  - an open combustion water heater, or
  - a solid-fuel stove or insert (wood or pellet).

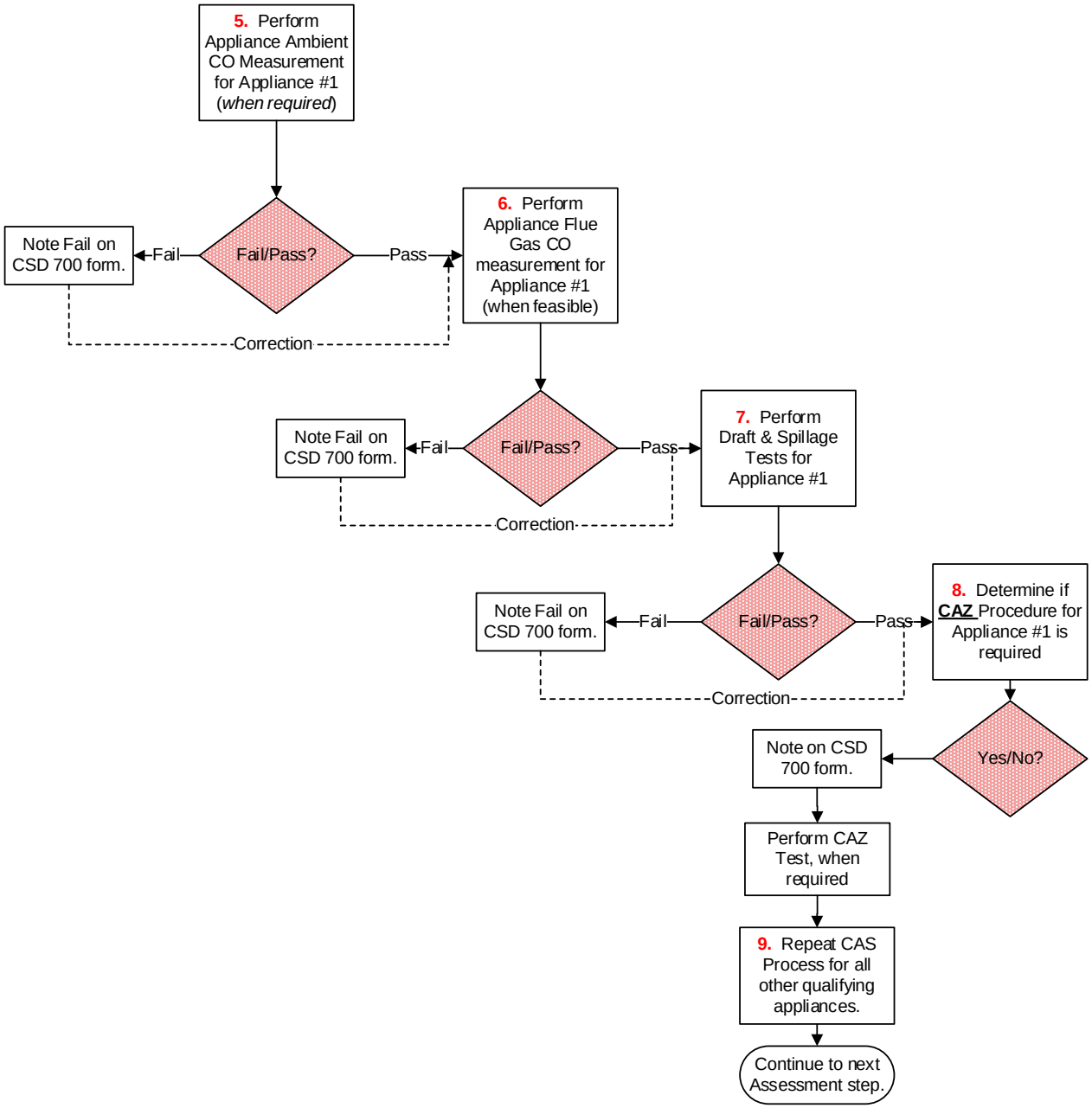
8.9 REPEAT STEPS 2 – 8

Now that you've used steps 2 through 8 to test one combustion appliance, all additional combustion appliances must be tested in the same way, by repeating the same steps.

8.10 CAS PROTOCOL FLOW CHART

The flow chart on the next two pages takes you through the whole CAS testing procedure. At each step, you will need to make a decision. The decision will take you to either the next CAS step—or to the correction that must be made, before the testing can continue.




5. Perform Appliance Ambient CO Measurement for Appliance #1 (when required)
Fail/Pass?
Fail
Note Fail on CSD 700 form.
Pass
6. Perform Appliance Flue Gas CO measurement for Appliance #1 (when feasible)
Correction
Fail/Pass?
Fail
Note Fail on CSD 700 form.
Pass
7. Perform Draft & Spillage Tests for Appliance #1
Correction
Fail/Pass?
Fail
Note Fail on CSD 700 form.
Pass
8. Determine if CAZ Procedure for Appliance #1 is required
Correction
Yes/No?
Note on CSD 700 form.
Perform CAZ Test, when required
9. Repeat CAS Process for all other qualifying appliances.
Continue to next Assessment step.

CAS Test Procedures

Photo Credit for all Photographs on this Page: WAPTAC.org

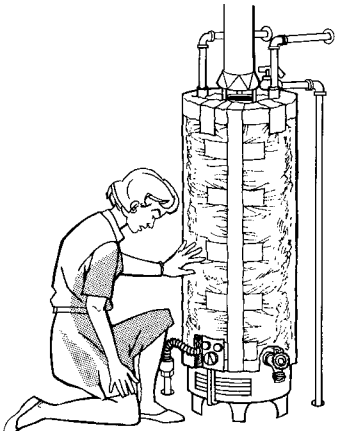
Step 1

GAS LEAK CHECK

REMEMBER: If any CAS Hazard or CAS Fail condition is identified that cannot be corrected:

- (DOE Program or dwelling leveraged with DOE) The dwelling shall be DEFERRED.
- (LIHEAP) The dwelling shall be NIM (non-infiltration reduction measures) only.

9. Gas Leak Check



Graphic Credit: RHA, Inc.

Assessors and crews must perform gas leak checks on ALL natural gas and propane-burning appliances, including gas log lighters, gas logs, and gas fireplaces/inserts.

9.1 TEST METHODS

Check for gas leaks shall be performed:

- Prior to conducting CO and Draft Tests.[2]
- With combustion appliances and exhaust fans/devices turned off.
- For all appliances affecting the living space, and when any part of a combustion appliance (appliance body or vent termination) is:
  - *Less* than 4' below or to the side of, or 1' above, an operable door or window into the living space, or
  - Clearances do not meet manufacturer's specifications, if different.
- Appliances shall be checked for gas leaks at fittings on valves, flexible gas connectors, and pipes (including caps on pipes and valves).
- One or more of the following methods shall be used to detect leaks. Additional detail about these tests is provided in Table 9.2.
  - Method (a): Air sampling with electronic leak detection equipment.
  - Method (b): Bubble Test with application of leak detection liquid.
  - Method (c): Olfactory ("Sniff"). This method is not an accepted "test", but may provide some indication that a leak is present.

9.2 GAS LEAK FOUND

A gas leak (natural gas or propane) is a CAS Hazard that must be corrected immediately upon identification of the hazard. Do not attempt to fix gas leaks, unless trained and specifically instructed by management to do so. Use this tool to remember what to do immediately:

STOP testing immediately. Postpone remaining CAS tests until after the leak is repaired.

TALK to the client. Warn him/her to not use the appliance or all other nearby combustion appliances (cook stove, clothes dryer, etc.) to avoid igniting leaking gas.

ORGANIZE. It may be necessary to help the client to contact the gas utility or propane dealer. If the leak is strong, evacuate the home before contacting the utility.

PHONE your supervisor to report the problem. Confirm with the client that the leak must be repaired immediately—within 18 hours.

[2] Gas control valves can start leaking *after* the burner lights, so an additional leak check should be done then.

If the odor of leaking gas is strong inside the house:

- Avoid using light switches, telephone, or flashlight (3-cell or larger), to prevent electric sparks that might ignite gas fumes.
- Telephone from outside the house (e.g., on a cell phone or a neighbor's phone).
- Wait outside for repair service, and do not turn off the gas at the meter (unless instructed to do so by the utility)—because:
  - Turning off the valve at the gas meter when the concentration is over 10% can allow dilution by air and return the mixture to a more dangerous state.

Gas leaks must be repaired only by qualified technicians (see Section 3).

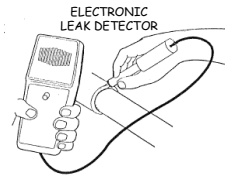
- A *strong* gas leak shall be fully corrected by a qualified technician before:
  - Appliances are operated for further CAS tests, or
  - Any infiltration-reduction measures are installed.

Record any information about gas leaks and details about their repair in the CSD 700 series forms.

- Note: When there is presence of a "fuzz leak" (identified as a non-existent or faint gas odor detected approximately 1-foot above the location and *very small* bubbles), CAS testing may continue; however, the fuzz leak shall be noted in the CAS Form (CSD 700 Form series), and the appliance shall be checked by a qualified technician before weatherization is complete.

Graphic Credit: PG&E Energy Training Center

TABLE 9.2: REQUIRED GAS LEAK CHECKS

Test Type	Application	Test Procedures	Precautions
Electronic Leak Detector  	Recommended method (easier for hard-to-reach locations, and doesn't rely on sense of smell). • Requires the technician to move the tester no faster than 1" per second to obtain a proper reading.	This is the best method when: • Appliance is difficult to move and/or may damage the floor, and/or • Flex connector is pre-1973 or older-style with soldered fittings. Check without moving the unit. • Check around fittings on valves, flexible gas connectors, and pipes (including caps on pipes and valves)	• Do not use an Electronic Leak Detector *after* applying a commercial leak detection liquid, because vapors from the liquid may produce a false positive result. • Always use the electronic leak detector first, and then use bubbles to locate any leak detected electronically.
Bubble Test  	Application of the commercial leak detection liquid or spray (or solution made with liquid detergent/soap and water), used to pinpoint the location of a leak found by smell or electronically.	Apply to fittings on valves, flexible gas connectors, and pipes (including caps on pipes and valves)—but avoid spraying into the internal parts of the appliance gas control valve.	Not feasible when: • Valves and fittings cannot be safely accessed, such as when an appliance is built-in. • Moving appliance is difficult and/or may damage the floor. In that case, dab or spray liquid onto any valves/fittings that can be reached without moving the unit.
Olfactory ("Sniff") Test  *Graphics Credits: RHA, Inc.*	This is not a standard test; however, technicians may also use their nose to smell for the odor of gas in the following locations: • Within 2 feet above natural gas valves and fittings. • Within 3 inches below propane valves and fittings.	If leak is detected by smell, technician must follow up with a Bubble Test to pinpoint location of the leak.	This method is the least precise and is not feasible when a compromised sense of smell cannot properly detect odorant. Note: Aldehydes have an acrid odor and irritate the nose and throat. Aldehyde odor is a sign of improper burner operation and creation of CO—and a warning to look for other defects and test for high CO.

9.3 GAS LEAK CORRECTION

After mitigation of a fuel leak, if repair/replacement is required, it shall be performed in accordance with TRM Appendix E, item 9.4.

If the home is a mobile home, and the appliance is not one that can be repaired or replaced in the CSD WAP (a DOE job), client permission must be obtained to safely remove the malfunctioning appliance. If removal is not allowed by the client, the dwelling must be deferred. Appliance abandonment is not allowed.

Using CSD WAP Health & Safety funds for environmental testing of soil or water is prohibited.

Step Two

VISUAL INSPECTION

REMEMBER: If any **CAS Hazard** or **CAS Fail** condition is identified that cannot be corrected:

- (DOE Program or dwelling leveraged with DOE) The dwelling shall be DEFERRED.
- (LIHEAP) The dwelling shall be NIM (non-infiltration reduction measures) only.

10. Visual Inspection

Assessors shall utilize the visual inspection process to identify and document the following CAS conditions on the CSD 700 (or 702) form.

- Appliance inaccessibility;
- Unvented heating systems, including use of cooking appliances to warm the home;
- Unsafe gas connectors;
- Vent, draft hood, and vent system abnormalities;
- Heat exchanger defects; and
- Lack of appliance safety features
  (such as combustion chamber cover or shield) and improper alterations.

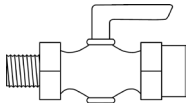
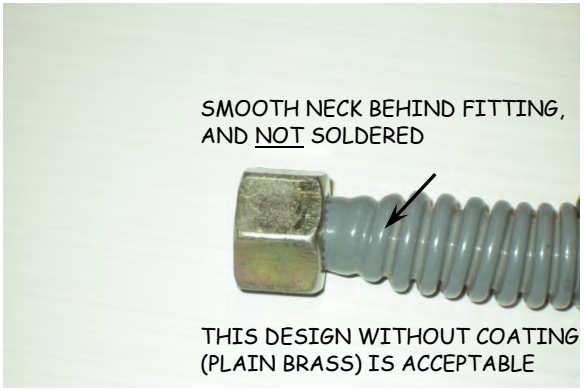
What Do I Do When…? CSD Policies Related to CAS Visual Inspections
When **visual inspection** identifies a repair issue (i.e., draft hood/vent pipe defects, nonconforming T&P, lack of enclosure, etc.) with an appliance that *does **not** affect the living space* • The appliance must be confirmed as belonging to the dwelling being served. • The repair issue must be identified and documented with photographs. • If "minor" correction is possible (such as CO, draft hood/vent pipe defect, non-conforming T&P, etc.), agency shall perform CAS test on the appliance and correct identified issues. • If "major" correction is required (i.e., heat exchanger replacement, relocation and/or construction of an appliance enclosure), full documentation is required, and a waiver must be sought in order to repair and relocate/enclose the appliance.
When **visual inspection** identifies a replacement issue with an appliance that *does **not** affect the living space* (i.e., leaking water heater, sediment build-up, etc.): • The appliance must be confirmed as belonging to the dwelling being served. • The replacement issue must be identified and documented with photographs. • The appliance shall be replaced and CAS tested as required by the CSD policy. • If the dwelling is tenant-occupied, the owner shall be notified in writing of the non-conforming condition, using a certified letter.
When **CAS inspection** identifies a non-conforming issue with a nonconforming appliance that ***does** affect the living space*: • The appliance must be confirmed as belonging to the dwelling being served. • The repair issue must be identified and documented with photographs. • If "minor" correction is possible (correction of draft hood/vent pipe defect, CO issue, non-conforming T&P, etc.), agency shall make correction and continue with weatherization. • CSD policies for repair or replacement in the measure-specific policies shall be followed.

10.1 TABLE: VISUAL INSPECTION– ALL APPLIANCES—ALL DWELLINGS

Assessors shall check for each of the following additional defect types in all combustion appliances. Each of the conditions below is considered a **CAS Fail**, except where noted as a **CAS Hazard**. Infiltration-reduction measures shall not be installed until ***the Fail or Hazard is first repaired by the client or by the weatherization program***.

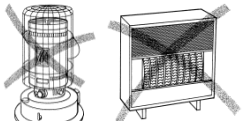
VISUAL INSPECTION—ALL DWELLINGS	
ALL COMBUSTION APPLIANCES	**INSPECTION REQUIREMENTS**
Appliance Accessibility 	CAS testing is required for all combustion appliances that affect the living space. When an appliance affecting the living space cannot be tested because it is inaccessible, the home shall be deferred (DOE) or NIM/no infiltration measures (LIHEAP). Inaccessible appliances must be noted on the CSD 700. Examples include: • Water heater in locked room/enclosure for which a key is not available or entry is not possible. • Attic-mount combustion appliance in a multi-family apartment unit that requires entry through an inaccessible unit. • Floor furnace in a crawl space with inadequate crawl clearance. • Floor furnace that has gas line still connected and has been turned off and covered over by plywood or attached floor covering (e.g., wall-to-wall carpet or vinyl). Note: Such an appliance should be “abandoned”, so installation of infiltration–reduction measures is allowed. • Floor or wall furnace that has been turned off and blocked by heavy furniture (e.g., a hutch or cabinet). Under LIHEAP, all other appliances affecting the living space *in addition to* the inaccessible appliance shall be tested and repaired or replaced as appropriate.
Appliance Components Defective, Missing, or Improperly Modified	The following appliance components shall be present in order for an appliance to meet minimum safety considerations: • Appliance door(s), including air handler compartment door. • Combustion chamber access door(s). Note: Gas water heaters shall have at least an access cover or roll-out shield. • Wall furnace front cover/grille (Cover/grille shall not be missing or damaged enough to make the unit unsafe to occupants). • On closed combustion appliances, and FVIR-compliant water heaters, the combustion chamber access panel/cover must be properly secured in place and sealed.

10.2 TABLE: VISUAL INSPECTION– FUEL LINES

VISUAL INSPECTION—ALL DWELLINGS	
APPLIANCE FUEL LINES	**INSPECTION REQUIREMENTS**
Appliance Line (Shutoff) Valves Not In Use  UNUSED SHUTOFF VALES MUST BE CAPPED *Graphic Credit: RHA, Inc.*	Appliance line (shut-off) valves that are not being used shall be capped with brass caps for flare fittings (not standard iron caps), or shall be removed and the pipe capped. The appliance line valve shall be temporarily capped, when a defective appliance was removed for repair/replacement, and the appliance will not be reinstalled and reconnected to the gas line before weatherization is complete.
Butt-Soldered Flexible Gas Connectors	Soldered flexible connectors shall be replaced as described in Section 7.3.1. Any connector that is *leaking* is a **CAS Hazard** that requires immediate correction.  *Photo Credit: CROBERTS.com*
Gas Connector Replacement:  SMOOTH NECK BEHIND FITTING, AND NOT SOLDERED THIS DESIGN WITHOUT COATING (PLAIN BRASS) IS ACCEPTABLE *Photo Credit: RHA, Inc.*	An existing flexible gas connector is considered unsafe and must be replaced with a new, listed flexible gas connector when it is kinked, corroded, shows signs of visible wear, was manufactured before 1973, or has any soldered connections. Copper tubing used to connect a gas appliance is also considered unsafe. Replacement of a defective flexible gas connector, or of a copper tubing connector, is a standard procedure that must be performed, whether or not the appliance is repaired or replaced. If the local jurisdiction requires additional replacements (e.g., installation of hard pipe from the gas control valve to outside the housing of an FAU), agencies shall seek a program waiver. Also, it is the intent of CSD to always replace the flexible gas connector when a gas appliance (FAU, water heater, range, etc.) is replaced. This policy is effective as of the date of this CSD TRM.

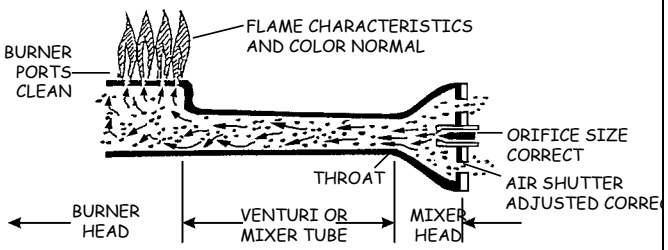
10.3 TABLE: VISUAL INSPECTION– OPERATIONAL CONDITIONS—ALL DWELLINGS

VISUAL INSPECTION—ALL DWELLINGS	
APPLIANCE OPERATIONAL CONDITIONS	**INSPECTION REQUIREMENTS**
Existing Wall Furnace in a Bedroom 	Repair or replacement of a wall furnace is not prohibited in a bedroom location. • For replacement of a unit in this location, a permit is required from the local jurisdiction and the replacement unit cannot have a manufacturer's restriction prohibiting installation in a bedroom.
Existing FAU or Open Combustion Water Heater Located within a Sleeping Area or Bathroom (Conventional Homes)	When an existing open combustion water heater or FAU is present in a sleeping area (including an attached garage converted to living space) or bathroom, it is a CAS Fail and corrective action by a qualified tech is required. • To correct the fail, a program waiver request must be submitted to 1) build an enclosure with a weatherstripped, self-closing door, and all CVA obtained from outdoors, or 2) replace the appliance with a direct vent, closed combustion unit. • If correction is not feasible, Section 5.1 of this appendix shall apply.
Existing Open Combustion Appliance Located in Any Room Other Than a Bedroom or Bathroom (Conventional Homes)	When an existing open combustion appliance is present in any room *other than* a bedroom or bathroom and takes air from the living space, the home is not NIM as long as there is adequate CVA (at least 50 cu. ft. per 1,000 BTU) in the combustion zone of that appliance.
Existing Open Combustion Appliances Located within a Manufactured Housing (Mobile Home) 	Cooking appliances, ovens, illuminating appliances, solid fuel burning fireplaces or stoves, or clothes dryers are the *only* open combustion appliances that are allowed to draw combustion air from a living space in mobile homes. • All other combustion appliances must be installed to provide for the complete separation of the combustion system from the interior atmosphere of the mobile home (i.e., to draw their combustion air from outside), and be vented to outside the dwelling. - A gas or solid fuel appliance that draws combustion air from a sleeping room or bathroom is a CAS Hazard. ▪ To correct the fail, a program waiver request must be submitted to 1) build an enclosure with a weatherstripped, self-closing door, and all CVA obtained from outdoors, or 2) replace the appliance with a direct vent, closed combustion unit. - Any other combustion appliance (gas or solid fuel) drawing air from the living space **is a** CAS Hazard, **except** as allowed by the following provision. ▪ Exception: If a natural draft wall furnace is present (but not in a sleeping room), shell sealing is allowed as long as pressure in the CAZ if no more negative than –1 Pa. (Note: If sealing activities do cause the zone to become more negative, supply mechanical ventilation shall be installed).

VISUAL INSPECTION—ALL DWELLINGS	
Existing Gas Log or Wood-Burning Fireplace within the Living Space (DOE Only)	Where a woodstove or fireplace insert is present within the living space, it is required to meet safety requirements. • Conduct a visual inspection of the entire system, including verification of adequate floor protection, code-compliant clearances to walls and other combustible materials, etc. • Perform visual draft testing to ensure proper operation of the appliance (see Table 15.5.1). • Fireplace or woodstove venting that is left operational after weatherization must meet current California Mechanical Code (i.e., the vent shall extend 3 feet above any part of the roof within 10 feet) and all local and national standards. • If it is unfeasible to make safe, dwelling deferral is required.
Existing Gas Log or Wood-Burning Fireplace Located within a Bedroom (All Housing Types)	When a gas log or wood-burning fireplace is present in a bedroom: • If there is a gas log in the fireplace, the damper must be blocked partially open with a damper clamp, or it is a CAS Hazard. Client education shall be provided regarding the safety considerations. - Clients with a gas log or wood-burning fireplace located in a bedroom shall receive special client education, warning them of the dangers of sleeping with these heat sources operating, and also highlighting the importance of not blocking the gap under the bedroom door to prevent drafts. - Client signature to document this education shall be obtained and kept in the client file. • If an existing woodstove or fireplace has sealed doors and takes all air from outdoors, or if a nonconforming woodstove can be replaced with a listed mobile home woodstove that draws all combustion air from outdoors, shell sealing is allowed.
Appliance(s) Not Properly Vented *Graphic Credit: RHA, Inc.*  UNVENTED HEATERS	Checks shall be made for lack of proper venting/exhaust, such as: • Any combustion appliance <u>not</u> properly vented to the outdoors (except cooktops and unvented ranges). • Gas range present which has a space heater or incinerator that is <u>not</u> vented outdoors. • Gas clothes dryer located in the living space <u>not</u> exhausted outdoors. • Clothes dryer (gas or electric) moisture exhaust that terminates in an open combustion appliance enclosure/closet. • Corrective action is required, or Section 5.1 of this appendix shall apply.

VISUAL INSPECTION—ALL DWELLINGS

Burner Abnormalities



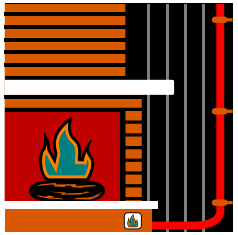
Graphic Credit: RHA, Inc.

- When the burner(s) ignite, inspections shall be made for:
  - Delayed ignition.
  - Excessive roll-out.
- Burner(s) shall be examined for flame abnormalities, including:
  - Soft lazy flame or smothering flame (flame recirculation); and
  - Large yellow flame (more than 50% yellow).
    - Note: Service is not required if (a) yellow flame is normal per manufacturer's specifications, and (b) it is not producing excessive CO or soot (e.g., carbon in the combustion chamber).
    - If dust has settled on the burner, dust should be removed and the burner re-checked.
- Corrective action is required, or Section 5.1 of this appendix shall apply.

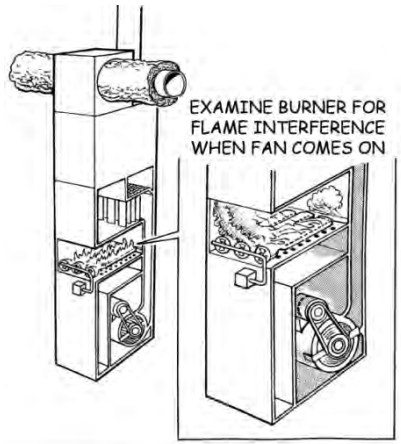
Carbon and Rust Deposits

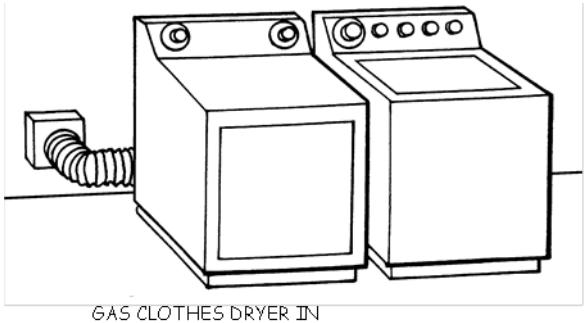
- Burner(s), heat exchanger, draft hood, and vent pipe shall be examined for carbon and/or rust.
- The presence of carbon or rust may indicate that an appliance is malfunctioning and shall be checked by a qualified technician.
- Corrective action is required, or Section 5.1 of this appendix shall apply.

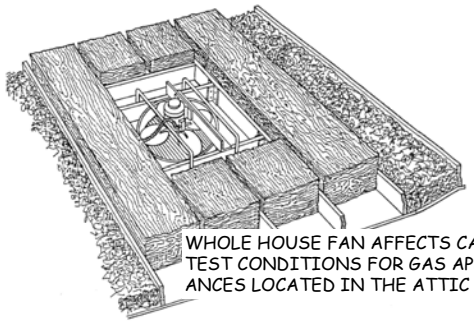
Damper Requirements for Fireplace with Gas Log



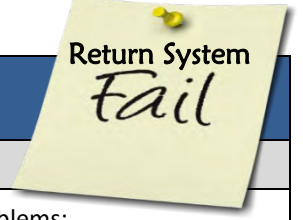
- When a CAS fail is identified with a fireplace with a gas log, or when a replacement damper will be installed, a spark arrestor must be in place or installed. The spark arrestor shall meet all of the following requirements:
  - The net-free area of the arrestor shall not be less than four times the net-free area of the chimney flue.
  - The arrestor screen shall be equivalent to 12-gauge wire, 19-gauge galvanized steel, or 24-gauge stainless steel.
  - The arrestor shall not allow sparks with more than 1/2" diameter to enter the chimney, nor shall it block sparks with less than 3/8" diameter.
  - The spark arrestor shall be installed to allow access for cleaning of the flue.
- When a gas log is in a fireplace, the fireplace damper shall be blocked open with a permanently installed damper clip that is open a sufficient amount to prevent spillage of combustion products into the room. For damper blocking, the CSD program does not distinguish between a fireplace/gas log that is a primary or secondary heat source.
- Occupants shall be advised of the nonconforming condition and the importance of making sure the damper is at least partially open when the gas log is operating.
- If a damper clamp is unfeasible, or refused by the client, Section 5.1 of this appendix shall apply.

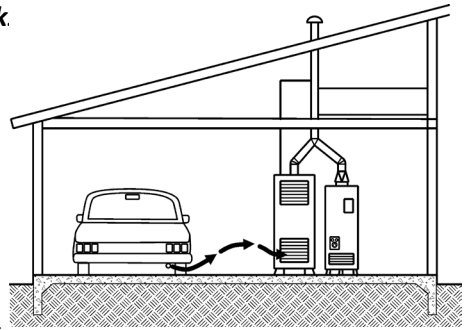
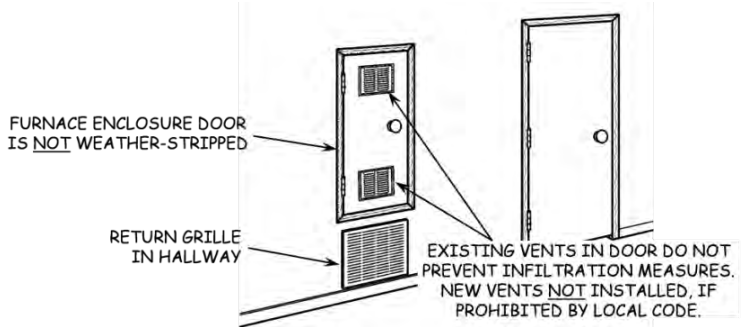
VISUAL INSPECTION—ALL DWELLINGS	
APPLIANCE OPERATIONAL CONDITIONS (CONTINUED)	**INSPECTION REQUIREMENTS**
Gas Water Heater Compartment Floor/Platform	The compartment floor or appliance platform shall be checked for structural integrity and strength. • It must be secure, stable, and level enough to properly and safely support the water heater. • The floor must be repaired or replaced (under the Limited Home Repair measure) when: 1) the appliance is leaning in an unsafe position, or 2) flooring is deteriorated to the extent that it is not safely supporting the tank. • Corrective action is required, or Section 5.1 of this appendix shall apply.
Space Heating Heat Exchanger Defects  Example of a cracked heat exchanger *Graphic Credit: WAPTAC.org*	• When accessible, the heat exchanger of each space heating appliance shall be inspected for cracks with a mirror and strong light. • The unit shall be further examined/serviced by a qualified technician if any of the following **CAS Hazard** conditions is present: - "Flame interference" occurs in an FAU when he air handler comes on, or - A visually-detected crack or other evidence of a defective heat exchanger, or - Appliance Ambient CO exceeds the second Living Space Ambient CO by *more* than 2 PPM. • If a defect exists, the condition shall be corrected *within 18 hours* of identification. • Corrective action is required, or Section 5.1 of this appendix shall apply.  *Graphic Credit: RHA, Inc.*
Clothes Dryer Moisture Exhaust System Visual Inspection	A gas clothes dryer located in the living space, or an attached garage used as living space, must be exhausted outdoors in conformance with the Limited Home Repair measure policies in CSD TRM Section 1. **Corrective action(s) is/are required or Section 5.1 of this appendix shall apply if the following Fails are not correctable.** • An existing moisture exhaust shall not: - Have leaks, obstructions, or improper termination (must terminate outdoors in a location where moist air will re-enter the living space). - Terminate in an open combustion appliance enclosure/closet. - Pass through an FAU plenum (unless material is hard pipe and sealed). • An installed moisture exhaust shall not: - Terminate less than 3' from an opening into the home, - Terminate less than 10' from the intake of a forced air (fan-driven) inlet.

VISUAL INSPECTION—ALL DWELLINGS	
Clothes Dryer Moisture Exhaust System Visual Inspection (cont.)  GAS CLOTHES DRYER IN THE LIVING SPACE AND EXHAUSTED OUTDOORS *Graphic Credit: RHA, Inc.*	- Terminate in an open combustion appliance enclosure/closet. - Pass through an FAU plenum. - Terminate within the living space or have no moisture exhaust that extends to the outdoors, • When an existing dryer moisture exhaust cannot be extended outdoors, the following shall result: - Dryer located in the Living Space: ▪ DOE Program, or when leveraged with DOE: Dwelling shall be deferred. ▪ LIHEAP: Home is NIM and mechanical ventilation shall be assessed. - If a dryer is located in an unconditioned dwelling area (i.e., an enclosed porch, attached garage, etc.), *not used as a living space,* the moisture exhaust shall be ducted to the outdoors and the home is <u>not</u> NIM. (Note: If the presence of lint creates a dangerous CAS or fire condition due to proximity to an open combustion appliance, it shall be handled as a CAS Hazard). ▪ Mechanical ventilation shall be assessed when required by program.
Improper Appliance <u>Location</u>	• When a combustion appliance draft hood, or any appliance vent termination, is located *within 4 feet* of an openable door or window, the appliance shall be fully inspected for all CAS Fails, including: - Gas leak; - Draft hood abnormalities; - Vent deficiencies or termination defects; - Burner abnormalities; - Carbon and rust deposits; - Excessive CO; and - Inadequate draft or spillage. • If *none* of these operational issues is present, the home is <u>not</u> NIM. • If *any* CAS Hazard or CAS Fail condition is present corrective action is required or Section 5.1 of this appendix shall apply.

VISUAL INSPECTION—ALL DWELLINGS	
APPLIANCE OPERATIONAL CONDITIONS (CONTINUED)	**INSPECTION REQUIREMENTS**
Improper Appliance <u>Modification</u>	Improper modifications to an appliance may include the following: • **<u>CAS Hazard</u>**: Incorrect burner orifice (e.g., propane gas used with natural gas orifice). This hazard requires installation of the correct orifice and removal of excess carbon/soot to correct the condition. • **<u>CAS Fail</u>**: Alteration of the gas control valve (correctable). • **<u>CAS Fail</u>**: Jumper installed to override a thermostat/control (correctable). Corrective action is required as described above, or Section 5.1 of this appendix shall apply.
Presence of a Whole House Fan  *Graphic Credit: RHA, Inc.*	• If a whole house fan vented into attic causes a natural draft water heater or FAU to fail the appliance CO or draft tests (see "Appliance CO Testing" section), the following steps shall be taken: - Calculate NFVA of the existing attic venting. - Determine outlet venting NFVA recommended by the whole house fan manufacturer. - Subtract existing attic venting NFVA from the recommended outlet venting NFVA to determine additional venting NFVA needed (if any) to meet or exceed manufacturer's recommendation. - Install additional attic venting, as needed. • If attic insulation will not be installed, a waiver is required to install additional attic venting. • If needed additional NFVA cannot be installed, corrective action is required, or Section 5.1 of this appendix shall apply.

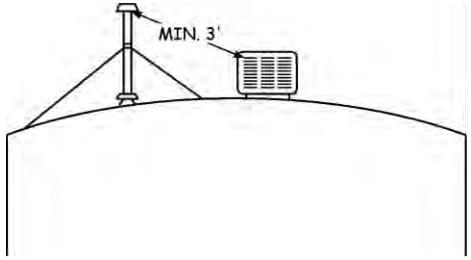
10.4 TABLE: VISUAL INSPECTION– RETURN SYSTEM ANALYSIS

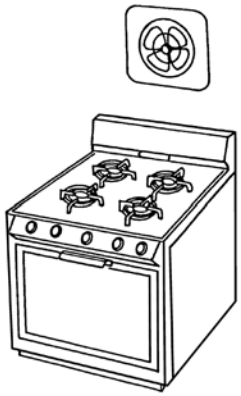
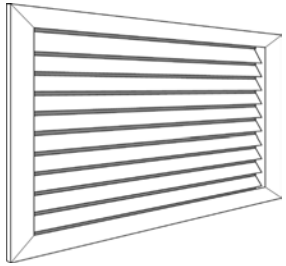


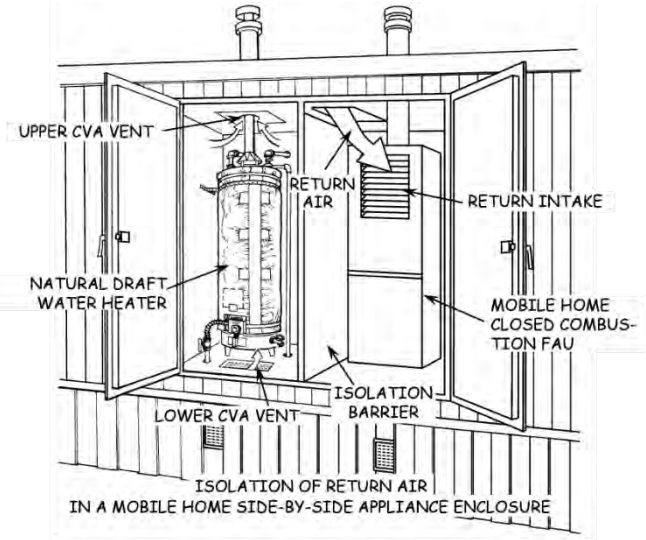
VISUAL INSPECTION—CONVENTIONAL HOMES	
RETURN SYSTEM ANALYSIS	**INSPECTION REQUIREMENTS**
Return System Leak  *Graphic Credit: RHA, Inc.*	• The return system shall not have leaks that can cause any of the following problems: - Depressurize any open combustion enclosure; - Draw in combustion air or combustion byproducts from any open combustion appliance (e.g., from the furnace itself or the nearby combustion appliance); - Depressurize or draw air from a garage or other space where hazardous chemicals are stored or toxic fumes may be present (e.g., where a car may be idling). • If correction or addition of an isolation barrier is not feasible, corrective action is required or Section 5.1 of this appendix shall apply.
Return Grille Adjacent to Appliance Enclosure Door	• The enclosure door shall be weatherstripped, if it does not seal tightly. - *Exception:* Not required when combustion air is taken from the living space. • Existing vents in the enclosure door do not NIM the home. • Unless prohibited by local code, it is acceptable to install new combustion air vents in the enclosure door, when there is no better CVA option.  *Graphic Credit: RHA, Inc.*
Prohibited Sources of Return Air	• Return air shall not be taken from a closet, bathroom, or kitchen. • When return air comes from any of those locations, replace the non-conforming return with a ducted central return that originates in an approved location. • Corrective action is required, or Section 5.1 of this appendix shall apply.

10.5 TABLE: VISUAL INSPECTION – MOBILE HOMES

Assessors shall check for each of the following additional defect types in all MOBILE HOMES. Each of the conditions below is considered a **CAS Fail**, unless noted as a **CAS Hazard**. Infiltration-reduction measures shall not be installed until ***the Fail or Hazard is repaired by the client or by the wx program***.

VISUAL INSPECTION – MOBILE HOMES	
MOBILE HOME NON-CONFORMING CONDITIONS	**INSPECTION REQUIREMENTS**
All Mobile Homes (DOE Only) 	Combustion appliances in mobile homes must comply with the US Department of Housing and Urban Development (HUD) *Manufactured Home Construction and Safety Standards*. • All combustion appliances installed by or left in place after weatherization in mobile homes must meet these HUD standards, including secondary heating sources. • Malfunctioning combustion appliances shall be repaired or replaced before weatherization, or they must be removed. - Note: Not all combustion appliances are served within the CSD WAP, but still would require removal. • If an occupant will not allow the removal of any unsafe combustion appliance from the home (includes all combustion appliance types), deferral is required. • All fuel-burning appliances must be installed with complete separation of the combustion system from the interior atmosphere of the home (i.e., drawing combustion air from outdoors) and be vented to the outdoors. - Exception: Ranges, ovens, illuminating appliances, clothes dryers, solid fuel-burning stoves, and fireplaces • If complete separation cannot be achieved, the appliance must be removed from the dwelling or deferral is required.
Gas Vent Terminals  *Graphic Credit: RHA,*	• Undercarriage Area: Vent pipes shall not terminate underneath a mobile home. • Evaporative Cooler: Water heater and furnace vent pipes located near an evaporative cooler shall terminate at least 3' from the cooler intake. • *Exception* for an Inoperable Cooler: - When an evaporative cooler is inoperable, or the property owner wants it abandoned, the vent terminal clearances do *not* apply, if the cooler is removed and the roof opening is sealed. • *Exception* for Furnace Vent Pipe Near Cooler: Vent terminal clearance is not required under the following conditions: - All cooler discharge openings are equipped with a vent cover, and - The client is informed of the non-conforming vent termination and advised to keep cover(s) in place during the heating season, and

VISUAL INSPECTION – MOBILE HOMES	
MOBILE HOME NON-CONFORMING CONDITIONS	**INSPECTION REQUIREMENTS**
	- Occupant notification of non-conforming vent is documented in the CSD 700. • If clearance requirements are not met, or corrections cannot be made, Section 5.1 of this appendix shall apply.
Gas Cooking Appliances—Kitchen Ventilation for Mobile Homes  *Graphic Credit: RHA, Inc.*	• A functional kitchen exhaust system and vent to outdoors must be present or feasible to install above or near gas cooking appliances, or Section 5.1 of this appendix shall apply. • Requirement can be met with: - an exhaust fan, or - a passive ventilation duct. • See CSD TRM Section 11 *Kitchen Exhaust* for additional installation details.
Transfer Grille Is Required in Wall or Enclosure Door Separating FAU from the Living Space	• A transfer grille with sufficient NFVA shall be present in the enclosure door/wall that separates the FAU return intake from the living space, as described in **the** CSD TRM Section 8 *Ducting Repair, Sealing, and Insulation*. • If the existing grille is too small, or none is present, corrective action is required or Section 5.1 of this appendix shall apply.  EXAMPLE OF TRANSFER GRILLE REQUIRED TO PROVIDE ADEQUATE RETURN AIR PATH IN THE WALL OR DOOR SEPARATING THE FAU FROM THE LIVING SPACE *Graphic Credit: RHA, Inc.*

VISUAL INSPECTION – MOBILE HOMES	
MOBILE HOME NON-CONFORMING CONDITIONS	**INSPECTION REQUIREMENTS**
Isolation of Return Air  *Graphic Credit: RHA, Inc.*	When a gas water heater and FAU are in adjacent enclosures: • The water heater enclosure shall not be depressurized by an adjacent FAU enclosure that serves as the return plenum. • The "isolation barrier" (partition between the two enclosures) must be complete and intact and must totally isolate the two appliances. • When the enclosure partition is not complete and intact, that is a CAS Hazard. • Corrective action is required, or Section 5.1 of this appendix shall apply. - Any condition (e.g., a defective isolation barrier) that allows pollutants to be drawn into the FAU return shall be corrected, including for duct sealing. - Air leaks between the living space and the FAU and water heater enclosures shall be sealed via an intact, complete isolation barrier. - If complete isolation cannot be achieved (is unfeasible and beyond the scope of the program), Section 5.1 of this appendix shall apply, and a CSD 542 Deferral Form" shall be completed

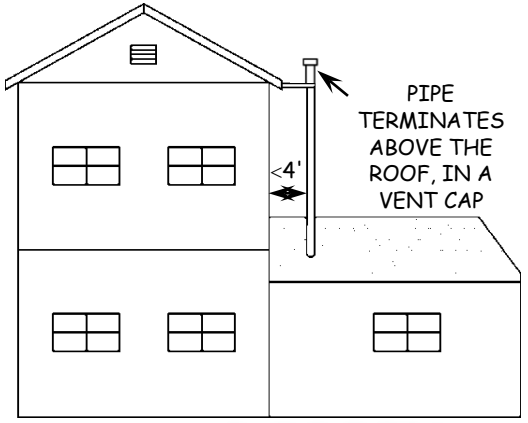
10.6 TABLE: VISUAL INSPECTION - VENT SYSTEMS

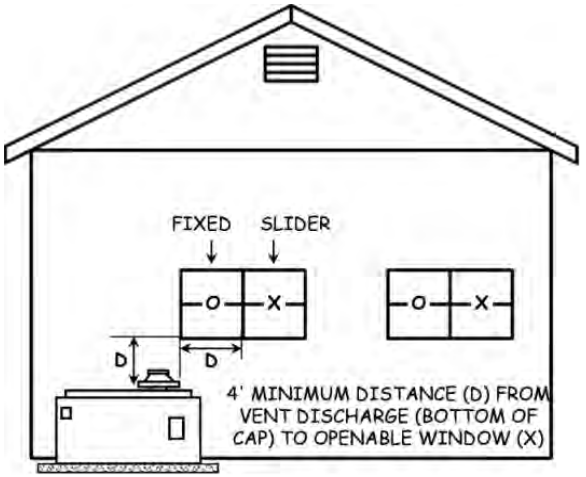
Assessors shall check for each of the following additional defect conditions in all vent systems. Each of the conditions below is considered a **CAS Fail**, unless noted as being a **CAS Hazard**. Infiltration-reduction measures shall not be installed until ***the Fail or Hazard is first repaired by the client or by the weatherization program***.

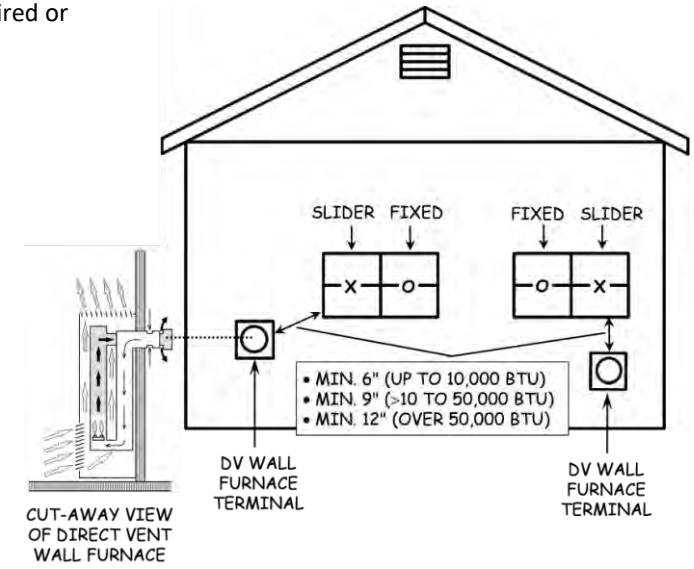
VISUAL INSPECTION OF VENT SYSTEMS—ALL DWELLINGS	
VENT SYSTEM AND DRAFT HOOD ABNORMALITIES	**INSPECTION REQUIREMENTS**
All Appliances  *Photo Credit: RHA, Inc.*	• Non-conforming vent systems shall be corrected before infiltration-reduction measures will be installed. Corrective action is required or Section 5.1 of this appendix shall apply. - Visual inspection includes checks for vent system defects in both fail categories. - Note: A vent system Fail is a "non-conforming" condition that does not cause CO to enter the home, and a Hazard is a condition that does cause CO to enter the home. **CAS Hazards**, *which requires correction within 18 hours,* include the following: • A vent system with a section missing, disconnected joint, hole, crush/obstruction, draft hood defect, or any other condition that adversely affects draft and causes combustion byproducts to enter the home. • A vent termination (most commonly that of a water heater) that is too close to an evaporative cooler intake. **CAS Fails**, *which require correction within 20 business days*, include the following non-hazardous vent defects, when they do not cause CO to enter the home: • Misaligned draft hood, multiple draft hoods, or no draft hood, *without* spillage. • Vent pipe needing screws due to loose/unsafe joint, or a defective/missing vent cap. • Single-wall pipe installed where double-wall pipe is required (e.g., in an attic or outdoors). • Damper in fireplace with gas log not blocked partially open, when the gas log is the home's primary heat source. • Inadequate clearance to combustibles causing visible evidence of a fire danger, including charring of wood, melting of foam insulation, etc. • Connection to a solid-fuel appliance chimney.
Clearance to Combustibles 	Corrective action is required or Section 5.1 of this appendix shall apply. • Newly installed single-wall pipe shall have 6" clearance to combustibles (wood framing, drywall, etc.). • Newly installed double-wall pipe clearance is as specified by the manufacturer, usually at least 1". • When clearance is less in *existing* vents, agencies or their subcontractors shall deem this an Advisory Condition. • Code-specified clearances are required for newly-installed vent system components.

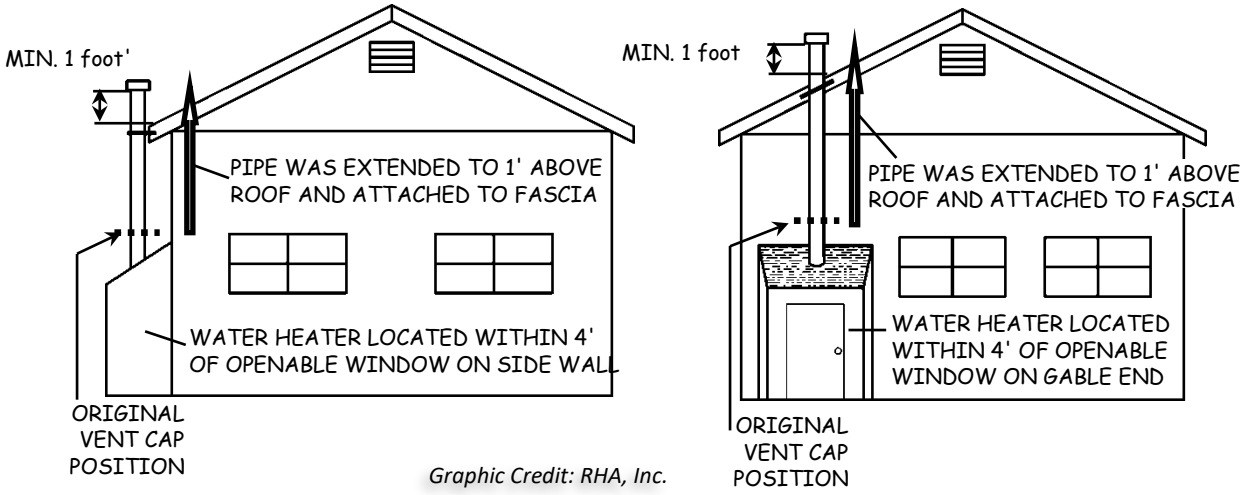
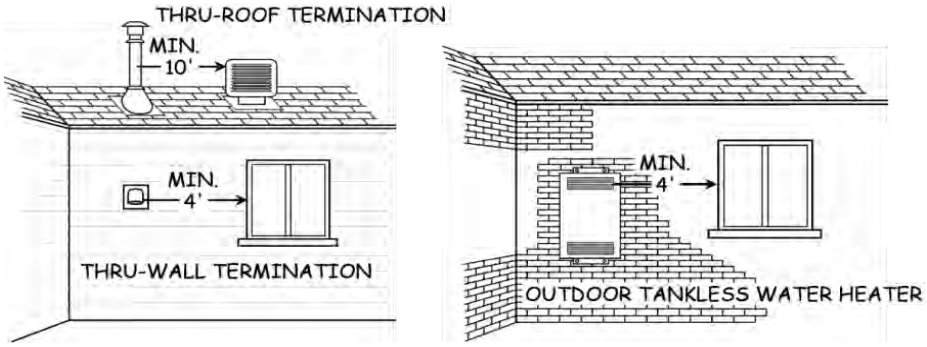
VISUAL INSPECTION OF VENT SYSTEMS—ALL DWELLINGS	
Combustion Appliance Vented to a Masonry Chimney	• (DOE only) If weatherization installs an appliance where the existing appliance was vented into a masonry chimney, the chimney must be lined in compliance with the International Fuel Gas Code (IFGC), California Mechanical Code, and local code (if more stringent).

VISUAL INSPECTION OF VENT SYSTEMS—ALL DWELLINGS	
VENT SYSTEM AND DRAFT HOOD ABNORMALITIES (CONT.)	**INSPECTION REQUIREMENTS**
Vent System Materials and Repairs  DOUBLE-WALL (TYPE B) PIPE  SINGLE-WALL VENT PIPE *Graphic and Photo Credit: RHA, Inc.*	• Single-wall pipe is called a "vent connector". It is used to connect a vented appliance to a double-wall pipe, known as "Type B" vent pipe. • A single-wall pipe vent connector is allowed only up to the ceiling or over to a wall, where it connects to a Type B vent pipe. The connection at a ceiling is usually in a "support box", and at a wall in a "thimble". • Double-wall pipe must extend: - Beyond the ceiling and through the attic to outdoors, and - Beyond a wall and up to a vent termination above the roof. • All-single wall vent pipe joints and connections shall be secured with 3 sheet metal screws (spaced as evenly as possible) where 1) existing connections are loose and unsafe, or 2) new components are installed. • Type B-vent pipe connections/joints shall not be drilled or have screws installed, unless allowed by the pipe manufacturer. • New vent system installations shall conform to local code. • Vent pipe material used/located incorrectly is an **Advisory Condition**, *unless* the vent pipe requires correction for a **CAS Fail** condition. Corrective action for the CAS Fail is required or Section 5.1 of this appendix shall apply.
Draft Hood Defects  *Photo Credit: Long Beach CAP*	All natural draft appliances have a draft hood. One purpose is to introduce "dilution air" into the vent system to help create and maintain proper drafting. Commonly-found draft hood defects include the following: • Misaligned (usually on a water heater). - The draft hood "feet" are not where they belong, and the draft hood is not centered over the flue. - This can usually be corrected by moving the draft hood into its correct position, and securing one or more feet with a sheet metal screw. - If the vent pipe does not line up with the draft hood, it may be necessary to install an offset (adjustable elbow) in the vent pipe (or on top of the draft hood). • Missing or doubled (stacked) draft hoods. - The draft hood being missing is usually because a new tank was installed that is taller than the old one. Rather than shortening the vent pipe, the draft hood was eliminated. - The draft hood being doubled is usually because a new tank was installed that is shorter than the old one. Rather than lengthening the vent pipe, the new draft hood was installed on top of the old one. • These conditions are all CAS Fails. If spillage is occurring, that is a CAS Hazard. Corrective action is required or Section 5.1 of this appendix shall apply.

VISUAL INSPECTION OF VENT SYSTEMS—ALL DWELLINGS	
VISUAL INSPECTION OF VENT SYSTEMS—ALL DWELLINGS	
PROPER (CORRECT) VENT TERMINATIONS	
Vent Terminations— Existing and Newly-Installed	• See an overview of program criteria, based on CMC requirements, in Table 10.6.1. Note that requirements differ by appliance type, location of the vent pipe, and type of home (conventional or mobile).
Correct Positioning— EXISTING Standard Vent Pipe	***Existing Vents that Penetrate a Roof:*** • The existing vent pipe may terminate less than 1 foot above the roof, as long as it extends through the roof and the appliance passes draft test and spillage check. • It is a **CAS Fail** if the appliance does not pass draft test and spillage check (regardless of vent terminal location). ***Existing Vents Near a Wall*** • A vent pipe located *at least* 4 feet way from a wall is not required to terminate above the wall. • A vent pipe located *less than* 4 feet away from a wall must terminate above the roof. If it does not, that is a CAS Fail. • It is also a CAS Fail when any vent pipe terminates less than: - 4-feet below or to the side of, or 1-foot above, an operable door or window. • Corrective actions are required or Section 5.1 of this appendix shall apply.  *Graphic Credit: RHA, Inc.*

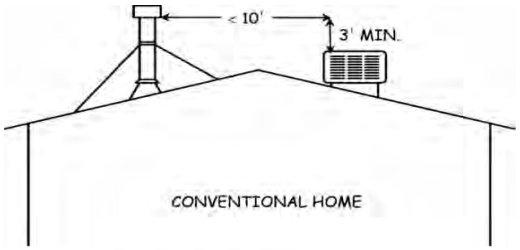
VISUAL INSPECTION OF VENT SYSTEMS—ALL DWELLINGS	
Gas Vent Terminals— Below a Door or Window (Clearances in Feet)	Corrective action if clearance is not met when required or Section 5.1 of this appendix shall apply. *Graphic Credit: RHA, Inc.* 

VISUAL INSPECTION OF VENT SYSTEMS—ALL DWELLINGS	
Gas Vent Terminals— Direct Vent Appliances (Clearances in Inches)	Corrective action if clearance is not met when required or Section 5.1 of this appendix shall apply. *Graphic Credit: RHA, Inc.* 

VISUAL INSPECTION OF VENT SYSTEMS—ALL DWELLINGS	
Gas Vent Terminals— Outdoor Water Heaters	Corrective action if clearance is not met when required or Section 5.1 of this appendix shall apply.  *Graphic Credit: RHA, Inc.*
Clearances for— Gas Tankless Water Heaters	Corrective action if clearance is not met when required or Section 5.1 of this appendix shall apply.  *Graphic Credit: RHA, Inc.*

VISUAL INSPECTION OF VENT SYSTEMS—ALL DWELLINGS

Gas Vent Terminals—
Near A Cooler or Mechanical Vent Inlet



Graphic Credit: RHA, Inc.

<u>Water Heater</u> Vent Terminals—CONVENTIONAL HOMES

- Vent terminal located within 10' of a forced air (fan-driven) or mechanical vent inlet shall terminate at least 3'above it—<u>unless</u> the cooler is removed and roof opening is sealed.
- Corrective action if clearance is not met when required or Section 5.1 of this appendix shall apply.

<u>Furnace</u> Vent Terminals

- Applies to all open and closed combustion appliances, *except* direct vent wall furnaces.
- A furnace vent terminal located within 10' of an inlet shall terminate at least 3' above the inlet.
- Corrective action if clearance is not met when required or Section 5.1 of this appendix shall apply.
- *<u>Exceptions</u>*: Clearances <u>not</u> required when:
  - All cooler discharge openings are equipped with a vent cover, or
  - The cooler shares the duct system with the FAU, and there is present a functional damper that isolates the cooler from the duct system during the heating season, or
  - The cooler is removed and the roof opening is sealed (e.g., when cooler is inoperable).
- When the exception applies, occupants shall be informed of it and advised that, during the heating season, they should do whichever of the following applies:
  - Keep the vent cover(s) in place, or
  - Keep the damper completely closed to isolate the cooler.
- Non-conforming vent termination shall be documented in the CSD 700 and occupant shall be notified.

10.6.1 TABLE: VISUAL INSPECTION–PRE-EXISTING VENT PIPE—EVALUATION AND CORRECTION REQUIREMENTS†

***REMINDER**: Corrective action is required if clearance is not met when required, or Section 5.1 of this appendix shall apply.

Appliance Type	Vent Location	Applies to	CAS FAIL Condition*	Termination Requirement	Additional Requirements
Natural Draft	Vertical pipe terminates **at least 4'** from a wall/ obstruction^.	Vent pipes that pass through the **roof**.	CAS Fail*, if vent pipe terminates less than 1 foot above the roof and the appliance fails draft and spillage checks.	• Not required to extend a full foot above the roof, IF the appliance passes draft and spillage checks.	• Vent cap required*.
	Vertical pipe terminates **<4'** from a wall.	Vent pipes that pass through a **wall** or terminates <4' from a wall.	CAS Fail*, if vent pipe terminates below roof.	• Shall extend vertically and terminate above the roof. • Note: Vent terminals <4' from an openable door, window, or gravity air inlet into the building must extend above roof.	• Vent cap required*.
	Vertical pipe terminates **<4'** from a wall/obstruction**^** (e.g., 2nd story wall).	Vent pipes that pass through a **roof** (e.g., garage roof) near a wall.	CAS Fail*, if vent pipe terminates less than 2-feet above the roof and the appliance fails draft and spillage checks.	• Vent pipe is not required to extend 2' above the roof, IF the appliance passes draft and spillage checks.	• Vent cap must be present and located higher than the adjacent roof*.
	Horizontal pipe in sidewall.	Vent pipe passes through a **wall**.	CAS Fail*, if outdoor pipe is single-wall or vent pipe terminates below roof.	• Double-wall pipe or thimble shall extend through the wall and terminate in vent cap. • Outside the wall, double-wall pipe must turn 90° and extend above the roof.	• If single-wall is *corrected**, it must be replaced with double-wall pipe that extends upward to 2' higher than any portion of the building within 10'.
Other Combustion Types	Terminates **<4'** from a wall	• Package units (integral vent). • Induce draft. • Power vent. • Outdoor tankless water heater (no vent pipe).	CAS Fail*, if termination is nonconforming and not corrected.	Gas vents shall terminate no closer to a door, window, or gravity air inlet into the building, than the following minimum distances: • 4' below, or 4' horizontally from, or • 1' above.	• Vent cap required on induced draft and power vent units*. • Note: Package FAU and outdoor tankless units—correction requires moving the appliance or eliminating the opening/inlet into the building.
	Vent Pipe (horizontal) extending through sidewall.	• Power vent. • 90+ closed combustion (condensing furnace).	CAS Fail*, if termination is nonconforming and not corrected.	• If so designed, may terminate directly outside the wall (upward extension not required). • Must have 4'/4'/1' clearances from door, window, or gravity inlet (see criteria above).	• Vent must terminate in accordance with manufacturer's instructions. • May be directed downward and have no vent cap.
		• Direct vent wall furnace.	CAS Fail*, if terminal requirement is not met and not corrected.	Direct vent wall furnace terminal shall be at least the following minimum distances for any air opening into the building: • 6″ for inputs up to 10 kBtu. • 9″ for inputs up to >10 kBtu up to 50 kBtu. • 12″ for inputs over 50 kBtu.	• Listed vent terminal must be in place*. • Note: Clearance *exceptions* for direct vent wall furnace terminals near an evaporative cooler are illustrated in Table 10.6.

Appliance Type	Vent Location	Applies to	CAS FAIL Condition*	Termination Requirement	Additional Requirements
Outdoor Storage Water Heater Vent	Vent pipe terminates below the roof, in a location that affects the living space.	• Storage water heater located adjacent to a dwelling wall (e.g., in a small enclosure near or against a side/end wall).	• Outdoor vent is single-wall pipe*. • Vent is less than 1' above roof or within 4' of an operable door or window*. • Vent cap is missing*.	Must terminate at least 1' above the roof and be: • Secured to the fascia or penetrate the roof and flashing. • In conformance with local code. • If offsets are used, offsets shall not exceed 45°, except one 60° offset is allowed.	• Vent cap required*. • Type-B vent pipe (double-wall) is required*. • If offsets are used, offsets shall not exceed 45°, except one 60° offset is allowed.
Outdoor Tankless Water Heaters	Vent pipe terminates below the roof, in a location that affects the living space.	• All outdoor tankless water heaters with vent pipe.	• Outdoor vent is single-wall*. • Vent terminal less than 1' above roof or within 4' or an operable door or window*. • Vent cap is missing*.	• More than 4' below or to the side of, or 1' above, operable door or window, or • Manufacturer's specifications, if different.	• Vent cap required*. • When correction to the existing vent is required, the vent type shall be in accordance with the manufacturer's requirements.
	Outlet at top of outdoor tankless water heater.	• All outdoor tankless water heaters with NO vent pipe.	• Unit is within 4' of an operable door or window*. • Unit is within 10' of, and less than 3' above, a forced air (fan-driven) intake*.	• Unit is at least 10' away from, or at least 3' above, a forced air (fan-driven) intake. • More than 4' below or to the side of, or 1' above, operable door or window, or • Manufacturer's specifications, if different.	• N/A (Correction requires moving the appliance.)
Indoor Tankless Water Heaters	Vent pipe terminates below the roof in a location that affects the living space.	• Indoor tankless water heater with a vertical vent.	• Outdoor vent is single-wall pipe*. • Vent terminal less than 1' above roof or within 4' or an operable door or window*. • Vent cap is missing*.	• Vent must extend through roof and terminate in a listed vent cap or roof assembly. • When vent is located less than 4' from a wall, must terminate in a vent cap located higher than the adjacent roof.	• Vent cap required*. • When correction to the existing vent is required, the vent type shall be in accordance with the manufacturer's specifications.
		• Indoor tankless water heater with a horizontal vent.	• Outdoor vent is single-wall pipe. • Vent terminal < 1' above roof or within 4' of operable door/window*. • Natural draft vent does not slope upward at least 1/4" per foot of horizontal run*. • Vent cap is missing*.	• More than 4' below or to the side of, or 1' above, operable door or window into the living space, or • Manufacturer's specifications, if different.	• Vent cap required*. • When correction to the existing vent is required, the vent type shall be in accordance with the manufacturer's requirements.
Gas Vent Terminals Near a Forced Air (Fan-Driven) Inlet	• Too close to an **evaporative cooler** or mechanical vent inlet.	• Water heater vent terminals.	Home is NIM* ***except*** when: • Inoperable cooler is removed and roof opening is sealed.	• A water heater vent pipe located within 10' of a forced air (fan-driven) air inlet shall terminate at least 3' above it. For Mobile Homes, see table in Section 10.5.	• N/A
	• Near a forced air inlet (mechanical vent).	• Space heater vent terminals. • Applies to all open and closed combustion appliances, **except** direct	Home is NIM* ***except*** when: • All cooler discharge openings are equipped with a vent cover, or • Cooler shares duct system with the FAU, and there is a functional damper	• A space heater vent pipe located within 10' of a forced air (fan-driven) inlet shall terminate at least 3' above it. For Mobile Homes, see table in Section 10.5.	When a space heater vent termination does not meet 10'/3' clearances, inform client of non-conforming condition and advise that, during the heating season, they should (as applicable): • Keep the vent cover(s) in place, or

Appliance Type	Vent Location	Applies to	CAS FAIL Condition*	Termination Requirement	Additional Requirements
		vent wall furnaces. (See "Direct Vent" section.	that isolates the cooler from the duct system during the heating season, or • Inoperable forced air unit is removed and the roof opening is sealed.		• Keep the damper completely closed to isolate the cooler. • Document client notice in CSD 700.

† When correction includes installation of new vent pipe, the pipe type, vent cap, and terminal location must comply with local code. A permit must be obtained, when required by the local jurisdiction.
^ An "obstruction" is any surface angled more than 45 degrees above horizontal (e.g., wall, dormer, etc.).

10.6.2 TABLE: VISUAL INSPECTION–VENT CLEARANCES (NEW VENTS)

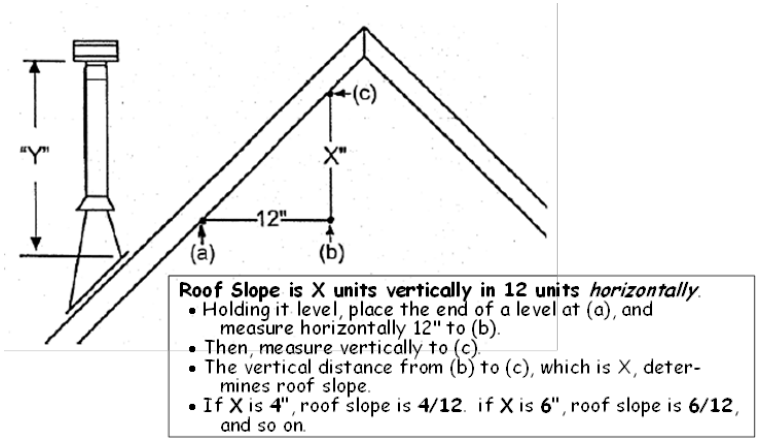
NEWLY-INSTALLED VENT PIPES FOR NATURAL DRAFT APPLIANCES—INSTALLATION REQUIREMENTS†

Type of Vent	Vent Location	Applies To	Installation Requirement	Additional Requirement
Natural Draft Vent	• As required by code and the local jurisdiction.	• For slopes up to 6/12.	• Must extend at least 1' above roof.	• Must be installed in conformance with manufacturer's instructions and local code.
		• For slopes greater than 6/12.	• Extension above the roof must comply with CMC Chapter 8, part of which is illustrated in the table below. • Height above roof is measured from the roof on the high side to the bottom of the exhaust opening (see below).	

† When correction includes installation of new vent pipe, the pipe type, vent cap, and terminal location must comply with local code. A permit must be obtained, when required by the local jurisdiction.

VENT HEIGHT FOR SOME ROOF SLOPES

ROOF SLOPE ("X" IN 12)	MIN. HT. ABOVE ROOF (DISTANCE "Y")	ROOF SLOPE ("X" IN 12)	MIN. HT. ABOVE ROOF (DISTANCE "Y")
Flat to 6/12	1'-0" (12")	>9/12 to 10/12	2'-6" (30")
>6/12 to 7/12	1'-3" (15")	>10/12 to 11/12	3'-3" (39")
>7/12 to 8/12	1'-6" (18")	>11/12 to 12/12	4'-0" (48")
>8/12 to 9/12	2'-0" (24")	>12/12 to 14/12	5'-0" (60")



Step 3

CVA EVALUATION

REMEMBER: If any CAS Hazard or CAS Fail condition is identified that cannot be corrected:

- (DOE Program or dwelling leveraged with DOE) The dwelling shall be DEFERRED.
- (LIHEAP) The dwelling shall be NIM (non-infiltration reduction measures) only.

11. CVA Requirements

Photo Credit: RHA, Inc.

Assessors and field crews must evaluate existing combustion and ventilation air (CVA) to ensure safe operation of open combustion appliances. CVA shall:

- Comply with CSD guidelines (unless superseded by manufacturer's instructions or local code).
- Be corrected, if non-conforming or inadequate.

There are five (5) steps to evaluate an appliance for CVA:

1. Identify all open combustion appliances at a dwelling.
2. Verify CVA source for each appliance. Does the air come from indoors, outdoors, or a combination?
3. Determine the minimum CVA required for each existing appliance.
4. Measure and calculate how much CVA is pre-existing.
5. Determine when additional CVA is needed; and if so, how much?

11.1 WHAT IS THE PURPOSE OF CVA?

CVA is needed in the appliance burner and combustion chamber ("combustion air") for a proper flame, and in the vent pipe ("dilution air") for proper drafting of combustion gasses.

- When there are both "upper" and "lower" CVA vents, combustion air enters the appliance enclosure primarily through the lower vent. Ventilation air vents heat and combustion gases out of the enclosure through the upper CVA vent.
- When there is "upper-only" CVA venting, that vent provides both combustion and ventilation air.
- The higher the Btuh Input rating is for an appliance, the greater the amount of CVA that is needed.

11.2 CVA CLIENT EDUCATION

Photo Credit: WAPTAC.org

In addition to understanding how to evaluate CVA and determine what corrections must be made, weatherization workers must also be able to explain CVA corrections to clients.

- Explain that gas appliances need "combustion air" to operate properly (to "breathe")—and that their appliance(s) do not presently have enough.
- Describe what must be done to correct the deficiency, such as:
  - For outside air, install larger vents to outdoors, or
  - For indoor room volume, install vents into an adjacent room (or install a louvered door, or permanently remove the solid door).
  - If the client resists taking feasible corrective action—or if correction is not possible—explain that infiltration-reduction measures shall not be installed.

– Always get agreement from the occupants, and written permission from the owner (or rental agent), before installing CVA vents or changing/removing a door.

Note: Because of the potential danger to occupants from CO poisoning, air sealing measures shall not be installed when CVA is not sufficient. Corrective action is required, or Section 5.1 of this appendix shall apply.

11.3 IDENTIFY APPLIANCE TYPE

CVA requirements apply to open combustion appliances that draw combustion air from the room/enclosure/space in which they are located. For each appliance in the living space listed below, you must perform a CVA evaluation:

- Open combustion furnace/heater
- Open combustion water heater
- Cooking appliances (for homes constructed from 2008 to the present time).

Open combustion appliances include "Natural Draft" (with a draft hood) or "Induced Draft" (with an inducer fan instead of a draft hood).

Figure 11.3.1 Natural Draft Furnace

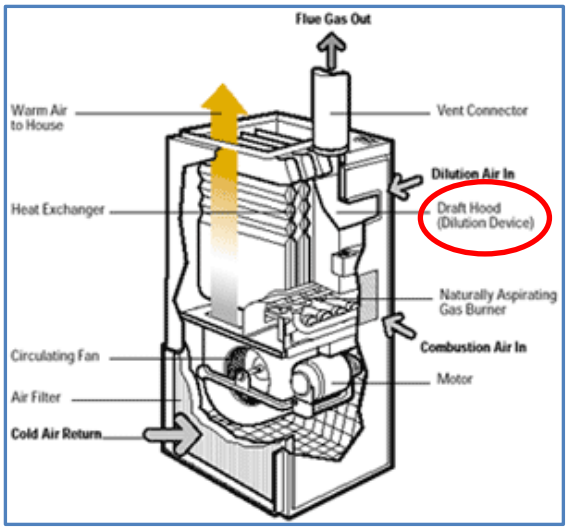
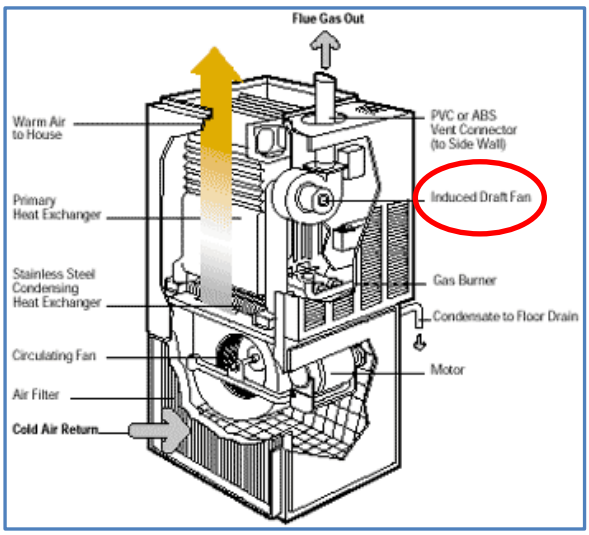


Figure 11.3.2 Induced Draft Furnace



11.4 SOURCES OF COMBUSTION AIR

The following are combustion air sources:

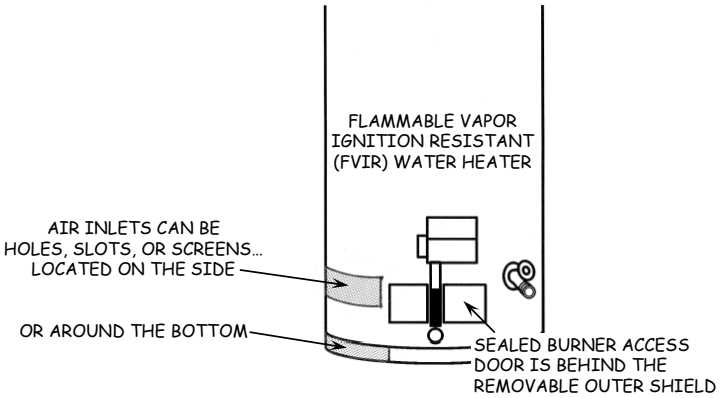
- Indoors—combustion air is based on *room volume* where the appliance is located.
- Outdoors—combustion ventilation air is supplied through CVA vents/grilles and ducts, which are sized to have the correct amount of "net free venting area" (NFVA). Where applicable and an appliance is replaced, combustion air shall be provided from the outdoors and installed in accordance with the 2012 IRC, manufacturer specifications, and additional applicable codes for the type of appliance installed.

- Both indoors and outdoors. This is a very undesirable condition when the appliance is in the living space, because a vent/duct to outdoors is actually a large shell leak. When possible within the scope of the program, CVA must be corrected to make all combustion air come from indoors or all from outdoors, for appliances located within the thermal envelope.

11.5 VISUAL EXAMINATION OF ALL EXISTING CVA VENTS

During the initial CVA evaluation, make sure to check and clear vents (or ducts) of obstructions like insulation, lint, animal hair, etc.

- Any obstructions must be removed during the home's assessment to ensure that combustion appliances are functioning properly during the CAS tests.
- Existing CVA vents to outdoors must also be evaluated to determine if they meet the requirements listed in Section 11.7 or require correction.
- Note: FVIR water heaters are very sensitive to obstruction to combustion air inlet vents. Check and clean inlets during the CVA evaluation. Occupants must be educated by the Assessor about how to clean the intakes and why it is important to clean them regularly.



Graphic Credit: RHA, Inc.

11.6 MINIMUM INDOOR CVA

11.6.1 HOW MUCH CVA IS REQUIRED?

Each room, enclosure, or space containing one or more open combustion appliance must provide a minimum room volume of 50 cu. ft. per 1,000 Btuh total input. The space where the appliance is located is called the "combustion appliance zone" or just "zone".

MINIMUM CVA	INSUFFICIENT CVA
At least 50 cu. ft. of room volume per 1,000 Btuh input	Less than 50 cu. ft. of room volume per 1,000 Btuh input

- When a zone has *at least* the minimum room volume, combustion air is adequate, and nothing needs to be done.
- When room volume of a zone is *less than* 50 cu. ft. per 1,000 Btuh total input, there is *insufficient* CVA volume
- If a client refuses to allow CVA to be corrected or added, Section 5.1 of this appendix shall apply.

To calculate indoor CVA, use the Sections 11.6.2 through 11.6.6 below.

11.6.2 CALCULATE INDOOR ROOM VOLUME

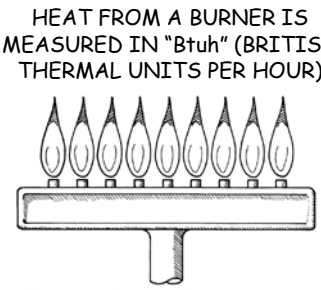
Indoor CVA is based on cubic feet of volume of the *indoor* room (zone) containing one or more appliances. To calculate room volume, multiply floor area times ceiling height.

- A 10'x 10' room with 8-foot ceiling has a volume of 800 cu. ft. (10 x 10 x 8 = 800).

If the CVA is insufficient, more room volume must be added—by venting into adjacent room(s).

11.6.3 CALCULATE INDOOR CVA

The minimum CVA requirement is based on the total Btu per Hour Input or "Btuh" of the appliance(s) inside an enclosure, room, or space. The Btuh Input can be read on the manufacturer's nameplate.



Graphic Credit: RHA, Inc.

- To calculate the existing indoor CVA, divide the Btuh input by 1,000. (Example: an 80,000 Btuh furnace ÷ 1,000 = 80 KBtuh); then multiply the KBtuh by 50 to determine the minimum amount of room volume that is required for the appliance(s).

Using the equation below, 80 (kBtuh) X 50 = 4,000 cu. ft.

TABLE 11.6.3.1—CVA FROM INDOORS

Application	CVA Requirement
All air from **indoors**, based on **room volume**	**Minimum Room Volume = KBtuh x 50**

There is a method called the "Known Air Infiltration Rate Method", which may be used when shell leakage is high. This method may reduce acceptable room volume to as little as 35 cu. ft. per 1,000 Btuh. Shell leakage CFM_{50} is used in the calculation, so a blower door test is required. More information is provided in Section 11.6.4.

When the nameplate is missing or illegible for an appliance, use the *default* Btuh values provided below. This table also appears in Section 17.

TABLE 11.6.3.2—DEFAULT BTUH VALUES

Appliance Type	Default Btuh Input Rating
Forced Air Furnace	• 25,000 Btuh per burner
Wall Furnace	• Single Sided: 35,000 Btuh • Double Sided with two burners: 60,000 Btuh
Floor Furnace	• Standard: 30,000 Btuh (usually 22" wide) • Large: 60,000 Btuh (usually wider than a single floor-joist bay)
Free-Standing (Room) Heater	• Small (up to 25" wide): 25,000 Btuh • Standard (26" to 32" wide): 50,000 Btuh • Large (34" or wider): 60,000Btuh
Gas Fireplace Unit	• 40,000 Btuh
Water Heater	• 1,000 Btuh per gallon
Cooktop Burners and Griddle	• 10,000 Btuh per burner
Oven	• 20,000 Btuh per burner

11.6.4 "KNOWN AIR INFILTRATION RATE" OPTIONS FOR INDOOR CVA VOLUME

When indoor CVA room volume is less than 50 cu. ft. per 1,000 Btuh, and installing CVA vents into adjacent spaces is not an option, it may be possible that a *smaller* room volume is acceptable.

- You must perform a blower door test, and then convert CFM_{50} shell leakage to "air changes per hour" (ACH), which is at natural pressure.
- The following table takes you step-by-step through the process.

TABLE 11.6.4: KNOWN AIR INFILTRATION RATE METHOD TO REDUCE CVA ROOM VOLUME

STEP #1: Calculate Actual ACH

Convert CFM50 to ACH at natural pressure.

1. Calculate "Interior Volume" of the dwelling.
   a. Use interior dimensions, or measure outdoor dimensions and subtract for wall thickness.
   b. Interior Volume (cu. ft.) = (floor area in sq. ft.) x (ceiling height in feet).

2. Use a Blower Door to measure CFM_{50} shell leakage, and calculate ACH to two decimal points. Use only one of the following equations:

Equation 1 for a **1-Story** Dwelling:

$$\textbf{ACH} = \frac{\textbf{(CFM}_{50}\textbf{) x 2.61}}{\textbf{cu. ft.}} = \frac{(CFM_{50}) \times (\text{1-story factor})}{\text{Interior Volume}}$$

Equation 2 for a **2-Story** Dwelling:

$$\textbf{ACH} = \frac{\textbf{(CFM}_{50}\textbf{) x 3.26}}{\textbf{cu. ft.}} = \frac{(CFM_{50}) \times (\text{2-story factor})}{\text{Interior Volume}}$$

Equation 3 for **3 Stories** or higher:

$$\textbf{ACH} = \frac{\textbf{(CFM}_{50}\textbf{) x 3.73}}{\textbf{cu. ft.}} = \frac{(CFM_{50}) \times (\text{3-story factor})}{\text{Interior Volume}}$$

Example for 1-story dwelling: Assume 1,000 sq. ft. of floor space, 8' ceilings, and 1,200 CFM_{50} shell leakage.

$$\text{ACH} = \frac{1{,}200 \times 2.61}{(1{,}000 \text{ sq. ft.}) \times (8 \text{ ft.})} = \frac{3{,}132}{8{,}000} = 0.3915 = \textbf{0.39 ACH}$$

Definitions for "Known Air Infiltration Rate Method" Equations 4 and 5

In the nest two equations, the following abbreviations are used:

$\mathbf{I_{Nat}}$	=	Input in Btuh* for Natural Draft appliances.
$\mathbf{I_{Fan}}$	=	Input in Btuh* for Induced Draft appliances (with inducer fan).
ACH	=	air changes per hour** *Maximum 0.60 ACH may be used in volume calculations.*

* When using these equations, "Input in Btuh" is the total for the gas appliances drawing combustion air from the room/space, which include: **space heater(s), water heater(s), cooktop, and oven.**

** The volume of indoor air changed in an hour compared to the total volume of air in the building, expressed as a decimal.

Continued on next page.

STEP #2(A): Known Air Infiltration Rate Method—Natural Draft Appliances

1. For Natural Draft appliances, use the equation below to calculate the required volume for CVA.

Equation 4:

$$\textbf{Required Volume}_{Nat} = \frac{\textbf{21 cu. ft.}}{\textbf{ACH}} \times \frac{\textbf{I}_{Nat}}{\textbf{1,000 Btuh}}$$

2. Note: 0.60 ACH is the maximum infiltration rate allowed in the calculation, and ***35*** *cu. ft. per 1,000 Btuh Input is the smallest acceptable volume for* ***Natural*** *Draft appliances,* regardless of calculation result.

3. Example: Assume infiltration is 0.50 ACH and total Natural Draft Input is 100,000 Btuh.

$$\text{Required Volume}_{Nat} = \frac{21 \text{ cu. ft.}}{0.50} \times \frac{100{,}000 \text{ Btuh}}{1{,}000 \text{ Btuh}} = 4{,}200 \text{ cu. ft.}$$

By knowing the infiltration rate from a Blower Door test and using Equation 4, the required volume is *reduced* 16% to just 4,200 cu. ft. for this sample natural draft appliance.

STEP #2(B): Known Air Infiltration Rate Method—Induced Draft Appliances

1. For Induced Draft appliances, use the equation below to calculate the required volume for CVA.

Equation 5:

$$\textbf{Required Volume}_{Fan} = \frac{\textbf{15 cu. ft.}}{\textbf{ACH}} \times \frac{\textbf{I}_{Fan}}{\textbf{1,000 Btuh}}$$

2. Note: 0.60 ACH is the maximum infiltration rate allowed, and **25** cu. ft. per 1,000 Btuh Input is the smallest required volume allowed for **Induced** Draft appliances, regardless of calculation result.

3. Example: Again assume infiltration is 0.50 ACH and total Input is 100,000 Btuh.

$$\text{Required Volume}_{Nat} = \frac{15 \text{ cu. ft.}}{0.50} \times \frac{100{,}000 \text{ Btuh}}{1{,}000 \text{ Btuh}} = 3{,}000 \text{ cu. ft.}$$

By knowing the infiltration rate from a Blower Door test and using Equation 5, required volume is *reduced* 20% to just 3,000 cu. ft. for this sample induced draft appliance.

STEP #2(C): Both Natural Draft and Induced Draft Appliances In the Same Space

When both a Natural Draft appliance and an Induced Draft appliance draw combustion air from the same room or space, do the following:

1. Calculate required volume for the Natural Draft appliance.
2. Calculate required volume for the Induced Draft appliance.
3. Add the two volumes together to determine the total Required Volume for both appliances.

11.6.5 WHEN ADDITIONAL INDOOR ROOM VOLUME IS NEEDED

When existing indoor room volume is not sufficient—less than 50 cu. ft. per 1,000 Btuh—additional room volume must be added—or the condition is a CAS Fail. Corrective action is required, or Section 5.1 of this appendix shall apply.

First, use this equation:

(Required CVA Volume) – (Existing CVA Volume) = Additional CVA Volume Needed.

Then, the Equation below tells you how to properly size upper and lower CVA vents into adjacent space(s). The volume of the additional room(s) is then added to the volume of the room containing the appliance.

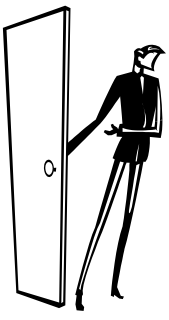
TABLE 11.6.5.1— MINIMUM CVA FROM INDOORS

Application	CVA Requirement
All air from **indoors**, with 1 Upper vent and 1 Lower vent venting to another interior room/space	When volume of a room/space containing an appliance is insufficient: • An Upper and a Lower vent shall be installed into adjacent space with sufficient volume. • Each vent must provide **1 sq. in. NFVA per 1,000 Btuh input**, with a *minimum size* of **100 sq. in.** per vent. **NFVA = 100 + # of KBtuh above 100**

Example: Required CVA room volume is 2,500 cu. ft., and existing (open area) room volume is 2,000 cu. ft.

- Using the equation above: (2,500) – (2,000) = 500 cu. ft., the amount of additional CVA volume required.
- If feasible, correct the condition by installing upper and lower 100 sq. in. NFVA CVA vents ("transfer grilles") into an adjacent room (or rooms) that can provide at least 500 cu. ft. of additional volume.

TABLE 11.6.5.2— CORRECTIVE ACTIONS FOR OBTAINING ADDITIONAL INDOOR CVA



To increase the amount of available CVA, it is required to do one of the following:

- Enlarge existing vents, or add additional upper and lower vents.
  - Minimum dimension of indoor CVA vents and ducts shall be no less than 3 inches. For example:
    - For a vent size of 30 sq. in., you can install a 3″ x 10″ vent or duct, but not a 2″ x 15″.
    - Round vents or ducts must have a minimum diameter of 3″.
- Replace the solid door with a louvered door.
- Permanently remove the solid door (in accordance with quality standards).

When removing a door to provide additional indoor CVA, the following requirements shall be met:

- All hinges shall be removed from the jamb.
- Mortise holes left by hinge removal shall be patched neatly.
- When touch-up paint is available from the client, at least one coat shall be applied.

When written permission is obtained from the owner (landlord or agent, if a rental), the removed door shall be taken away from the premises, and the client permission stored in the client file.

11.6.6 MOBILE HOME INDOOR CVA REQUIREMENTS

CVA requirements for mobile homes depend upon the types and locations of the appliances. Here is one specific standard related to indoor combustion air that applies to mobile homes for Space and Water Heating Appliances Drawing CVA from the Living Space:

- Infiltration-reduction measures shall not be installed, *unless* all of the following requirements are met for the mobile home:
  - Volume of the space supplying combustion air shall be at least 50 cu. ft. for each 1,000 Btuh input, and
  - The combustion appliance zone (CAZ) for each appliance is tested according to this protocol; and
  - Negative pressure in CAZ does not exceed the House Depressurization Limit (HDL).

11.7 MINIMUM OUTDOOR CVA

Many appliances are in small enclosures, garages, or other spaces, so they must get sufficient CVA from outdoors. Assessors must ensure that pre-existing vents provide the required net free venting area (NFVA). Minimum amount of CVA depends upon whether the existing vent(s) are:

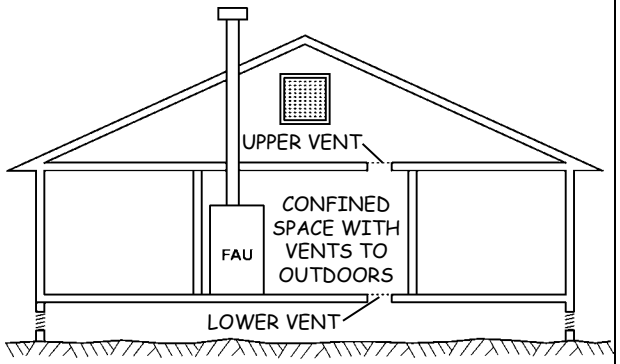
- Upper only
- Upper and lower vents or vertical ducts; or
- Upper and lower horizontal ducts.

If the existing vents do not meet the minimum of 50 cu. ft. per 1,000 Btu, the vents must be enlarged, or additional NFVA vents shall be installed, in accordance with the Table 11.7.2.

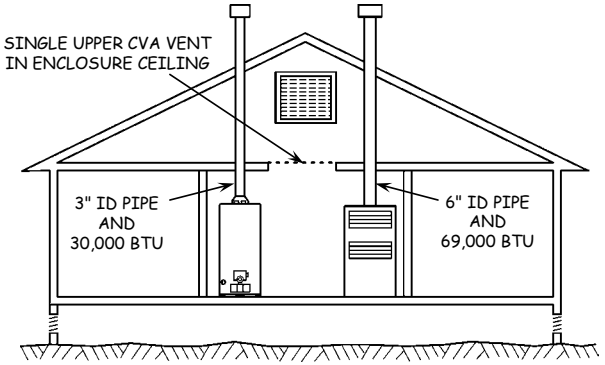
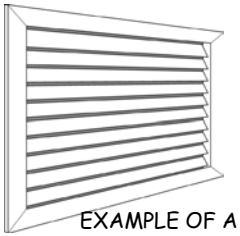
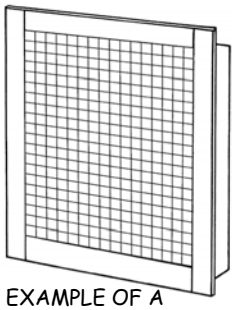
11.7.1 VISUAL EXAMINATION OF OUTDOOR CVA VENTS

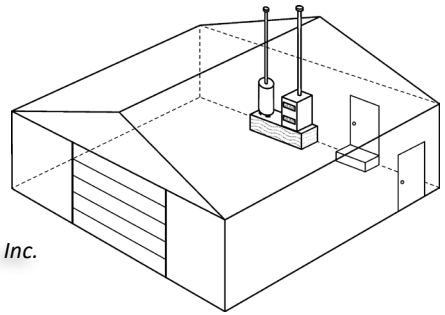
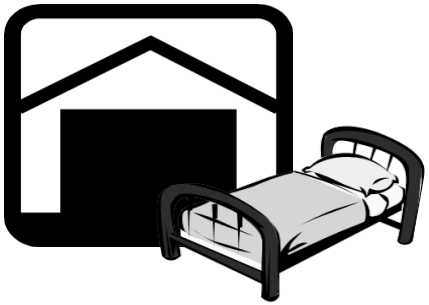
Since many appliances are in small enclosures, they must get CVA from outdoors. Combustion air reaches the appliance(s) through CVA vents or ducts to outdoors. Tables on the following pages summarize the minimum requirements for existing CVA vents from outdoors.

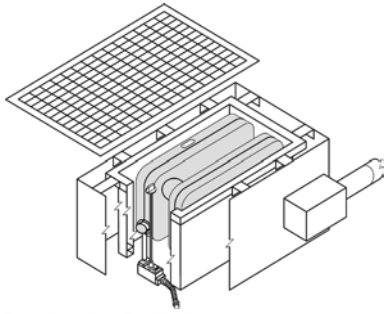
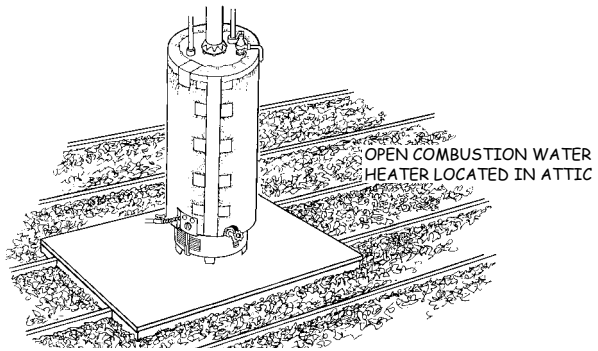
11.7.2 TABLE: POLICIES FOR EXISTING CVA VENTS TO OUTDOORS

<table>
<tr><th colspan="2">EVALUATION OF EXISTING CVA VENTS TO <u>OUTDOORS</u></th></tr>
<tr><th>TOPIC</th><th>EVALUATION REQUIREMENTS</th></tr>
<tr><td><u>All CVA Conditions</u></td><td>Corrective action is required when additional CVA is needed, or Section 5.1 of this appendix shall apply</td></tr>
<tr><td><u>All</u> CVA Vents and Ducts to <u>Outdoors</u> from the Living Space
 

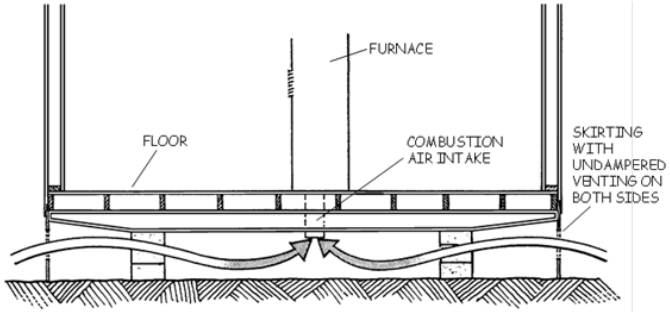
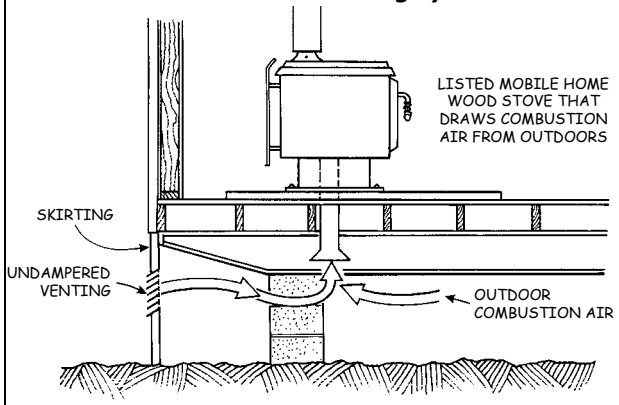
Graphic Credit: RHA, Inc.</td><td>CVA from outdoors must be obtained by one or more of the following methods:
• Permanent openings (with no damper) directly to outdoors through an enclosure floor, walls, or ceiling.
• Continuous vertical or horizontal ducts that extend from the enclosure to outdoors.
• It is acceptable to obtain CVA from attic and/or crawlspace when the attic or crawlspace vents conform with the following requirements:
<table><tr><th>AIR FROM ATTIC</th><th>AIR FROM UNDER FLOOR</th></tr><tr><td>Attic must have unobstructed cross ventilation, with NFVA that exceeds the CVA requirement.</td><td>• Crawlspace must have unobstructed cross ventilation, with NFVA that exceeds the CVA requirement.
• Crawlspace vents with closable louvers shall <u>not</u> be included in the NFVA calculation.</td></tr></table><u>Existing</u> CVA from outdoors can be supplied by:
• A combination of “upper” and “lower” vents or ducts, or
• Upper-only venting (when proper clearances are present in the enclosure.
- Note: If existing CVA is nonconforming, CVA must be brought to code and be upper-only, or upper and lower, in compliance with Table 11.7.3.</td></tr>
<tr><td>Existing CVA Vent Requirements – Ducts and Sleeves</td><td><u>Existing</u> CVA Ducts and Sleeves
• Minimum dimension of CVA vents and ducts to outdoors shall be no less than 3 inches. For example:
- For a vent size of 30 sq. in., you must install a 3″ x 10″ vent or duct, but <u>not</u> a 2″ x 15″.
- Round vents and ducts must have a minimum diameter of 3″.
• Ducts shall terminate in an unobstructed location that allows the free flow of combustion air to the appliance.
• Horizontal combustion air ducts must be level or have an upward slope. They must <u>not</u> slope downward toward the source of combustion air.
• For CVA Supplied by Ducts:</td></tr>
</table>

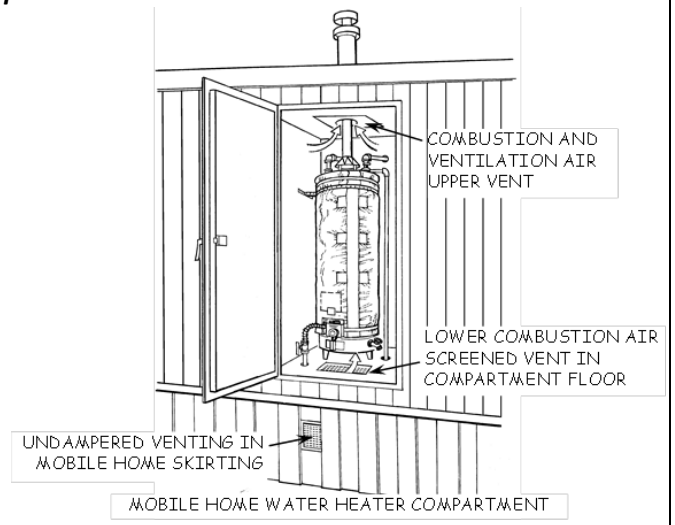
EVALUATION OF EXISTING CVA VENTS TO OUTDOORS	
TOPIC	**EVALUATION REQUIREMENTS**
Existing CVA Vent Requirements – Ducts and Sleeves (continued)	- Separate ducts shall be used for upper and lower CVA (a single duct cannot be used for both). - When wall stud bays are used as CVA ducts, a separate stud bay is required for each (both upper and lower vent screens must not be installed in the same stud bay).
Existing CVA Vent or Duct Positions— Upper or Lower  *Graphic Credit: RHA, Inc.*	**Examine all existing CVA Vents and Ducts.** • A *pre-existing* upper vent or duct at *any height above the draft hood opening* is acceptable during CVA evaluation of existing CVA only, but not when a new vent is installed. • A *pre-existing* lower vent at *any height above the floor* is acceptable during CVA evaluation of existing CVA only, but not when a new vent is installed. • For CVA Supplied by Upper Venting: Upper CVA venting shall not be provided by a duct extending up from the crawlspace. If this condition exists, it must be corrected. • For CVA Supplied by Lower Venting: When lower CVA is provided via a duct *from the attic,* the duct must begin above the ceiling insulation and extend down to within 12" of the floor, and the duct shall not have mesh at either end. If this condition exists, it must be corrected. • Enclosure with No Ceiling - When an interior appliance enclosure has no ceiling, equipment in the enclosure is treated as though it is located in the attic. - The open top of the enclosure is like a large upper-only CVA vent, so a lower vent is not required. - CVA for the enclosure is adequate if: (a) attic volume is at least 50 cu. ft. per 1,000 Btuh Input, or (b) attic venting provides the required amount of NFVA venting.
Louvers, Grilles, and Screens for Existing Vents  EXAMPLE OF A METAL TRANSFER GRILLE: *Graphic Credit: RHA,*  EXAMPLE OF A SCREEN-ONLY VENT	**CVA Vent or Duct Screens** • 1/4" mesh is acceptable on standard vents to outdoors. When mesh is present that reduces NFVA too much, it can be replaced with a larger weave up to 1/4" mesh to increase NFVA without enlarging the vent. • 1/16" mesh shall always be replaced with 1/4" mesh. • Note: A CVA duct that terminates in the attic shall not be screened on either end. The upper end of the duct shall extend above ceiling insulation, or must be extended with a sleeve when insulation will be installed. **Net Free Ventilation Area (NFVA)** • Vents with louvers, grilles, and screens do not allow full transfer of air, and must use a reduction factor when calculating the NFVA of an opening. • There are different "reduction factors" for each mesh weave, for metal louvers (with and without mesh), and for wooden louvers (with and without mesh). The rules and calculations are covered in detail in Section 11.7.5.

EVALUATION OF EXISTING CVA VENTS TO OUTDOORS	
TOPIC	**EVALUATION REQUIREMENTS**
Louvers, Grilles, and Screens for Existing Vents (continued)	• When NFVA of an existing CVA vent is too small, it may be possible to increase NFVA by removing existing mesh. - On screened vents to outdoors, remove 1/16" mesh and replace it with 1/8" hardware cloth (1/8" mesh is required on all CVA vents to outdoors). - On screened vents to indoors, just remove the mesh (because mesh is *not* required).
Open Combustion Appliances Located In a Garage (or Enclosed Porch) with No Sleeping Area  *Graphic Credit: RHA, Inc.*	**When the Garage/Porch Is Not Living Space** A special rule applies to the CVA evaluation for *existing* open combustion appliances located in an attached garage or enclosed porch. *This rule does not apply to CVA requirements for new appliances installed in those locations, which must conform to current code.* • When a garage is (a) unfinished or (b) finished but not living space: - Existing room volume must be at least 50 cu. ft. per 1,000 Btuh, - When garage or porch has insufficient room volume, venting to outdoors is required. • Permanent unblocked CVA vent(s) shall provide a total of at least 1 sq. in. NFVA per 4,000 Btuh total Input. (Note: Vents with a damper do not qualify). • It is acceptable for venting to be *upper only*, or *lower only*, or *upper and lower* vent(s). (It is *not* necessary to have both upper and lower vents in this special circumstance)
Open Combustion Appliances Located In a Garage (or Enclosed Porch) with a sleeping area 	**When the Garage/Porch Is Living Space** • A garage is considered a living space under the following conditions: - The drive-through door is permanently closed, - The interior is finished (e.g., with sheetrock or paneling), - There are no vents to outdoors/attic (ventilation or CVA vents), and - The room has the appearance of being used as living space. • A garage is considered a sleeping area if it also contains sleeping furniture or appears to be used for sleeping. • It is *conditioned* space, if a heating and/or cooling source is present (i.e., appliance or FAU supply register). **When the Garage Is Living Space with a Sleeping Area** • When an open combustion FAU and/or water heater is in a garage *that is used as a sleeping area*: - Section 5.1 of this appendix shall apply, even if room volume is equal to, or more than, 50 cu. ft. per 1,000 Btuh.

EVALUATION OF EXISTING CVA VENTS TO OUTDOORS	
TOPIC	**EVALUATION REQUIREMENTS**
Open Combustion Appliances Located In a Garage (or Enclosed Porch) with a sleeping area (continued)	- *Exception*: Correction of the condition shall be made by isolation of the appliance(s) by: (a) Building an enclosure to isolate the appliance(s) from the sleeping area that is adequately vented to the outdoors *and* has a weatherstripped self-closing door, or (b) sleeping facilities are removed from the living space.
Appliances Located in a Crawlspace, Basement, or Partial Basement  FLOOR FURNACES ARE IN THE CRAWLSPACE, BASEMENT, OR PARTIAL BASEMENT *Graphic Credit: RHA, Inc.*	**When an existing open combustion appliance is located in a crawlspace, basement, or partial basement** • When volume is *less than* 50 cu. ft. per 1,000 Btuh input, permanent CVA venting to outdoors is required. - Vent(s) shall provide a total of at least 1 sq. in. NFVA per 4,000 Btuh total Input. - Added venting may be *upper only* (it is *not* necessary to have both upper and lower vents in this special circumstance). - The under-floor space shall be have free flow of outdoor air (i.e., cross-ventilation), provided by unobstructed openings to outdoors (e.g., foundation vents). Vents with a damper do not qualify. *This rule does not apply to CVA for new appliances installed in those locations, which must conform to current code.*
Appliances Located in an Attic  OPEN COMBUSTION WATER HEATER LOCATED IN ATTIC UPPER AND/OR LOWER ATTIC VENTS WITH CROSS VENTILATION REQUIRED WHEN ATTIC IS A CONFINED SPACE CONTAINING AN OPEN COMBUSTION WATER HEATER AND/OR FAU *Graphic Credit: RHA, Inc.*	**CVA evaluation for existing open combustion appliances located in an attic** • When volume is *less than* 50 cu. ft. per 1,000 Btuh input, permanent CVA venting to outdoors is required. - Vent(s) shall provide a total of at least 1 sq. in. NFVA per 4,000 Btuh total Input. - Added venting may be *upper only*, or *lower only*, or *upper and lower* vent(s). (It is *not* necessary to have both upper and lower vents in this special circumstance). • The attic shall be have free flow of outdoor air (i.e., cross-ventilation), provided by unobstructed openings to outdoors (attic vents). Vents with a damper do not qualify. Note: *This rule does not apply to CVA requirements for new appliances installed in those locations, which must conform to current code (see Table 11.8.3 with information on installing a new appliance in this location).*

EVALUATION OF EXISTING CVA VENTS TO OUTDOORS

TOPIC	EVALUATION REQUIREMENTS
MOBILE HOME CVA TO OUTDOORS REQUIREMENTS CVA requirements for mobile homes depend upon the types and locations of the appliances. Corrective action is required when additional CVA is required, or Section 5.1 of this appendix shall apply. Below are three specific standards related to combustion air from outdoors that apply to mobile homes:	
Appliance Drawing Combustion Air from Under the Mobile Home  *Graphic Credit: RHA, Inc.*	• Un-dampered venting shall be present in the skirting. • Cross-ventilation shall be present, with venting located on at least two different sides of the Mobile Home (as illustrated at left). • Skirting vents shall provide a total of at least 1.5 sq. ft. NFVA for each 25 lineal feet of the Mobile Home.
Mobile Home Solid Fuel Heating System  *Graphic Credit: RHA, Inc.*	• When a mobile home has a wood-burning stove, it is acceptable to install shell sealing measures if the stove: - Is labeled for use in a mobile home, and - Draws combustion air ducted in from outdoors. • When a stove is present that is *not* labeled for use in a mobile home, shell sealing measures shall not be installed *unless* one of the following conditions is met: - Option 1: The stove is designed to operate with doors closed, and outside combustion air is ducted to the combustion chamber. - Option 2: When combustion air cannot be ducted directly to the combustion chamber, but the stove operates with doors closed: ▪ The CAZ is tested as prescribed, and ▪ Negative pressure in the CAZ does not exceed the applicable HDL.

EVALUATION OF EXISTING CVA VENTS TO OUTDOORS	
TOPIC	**EVALUATION REQUIREMENTS**
Open Combustion Water Heater CVA  *Graphic Credit: RHA, Inc.*	• An *upper* combustion air vent shall be present, which may consist of one of the following: - A round pipe-within-a-pipe vent assembly in the ceiling. This is when an appliance vent pipe surrounded by air space and a larger-diameter outer pipe. NFVA is cross-sectional area of the larger pipe minus cross-sectional area of the smaller pipe. - An undampered vent (screen or grille) installed in the door or outer wall and located higher than the draft hood. • A *lower* combustion air vent shall be present, which may be an undampered vent (screen or grille) to the outdoors, located in: - The enclosure floor, or - The door or wall, with the bottom beginning not *more* than 1' above the floor.

11.7.3 HOW MUCH OUTDOOR CVA IS REQUIRED?

The minimum CVA requirement is based on the total Btu per Hour Input or "Btuh" of the appliance(s). Find the Btuh Input on the appliance nameplate.

- To calculate existing CVA, divide the Btuh input by 1,000.
  For example, an 80,000 Btuh furnace ÷ 1,000 = 80 KBtuh.
- Then divide the KBtuh according to the appropriate formula below to determine the minimum amount of NFVA that is necessary for the appliance(s).

Table 11.7.3 shows how to determine the CVA vent size required based on the location of the existing CVA vents. The table provides 3 options (Note: When the nameplate is missing or illegible for an appliance, use the *default* Btuh values already provided in Section 17):

TABLE 11.7.3: MINIMUM CVA FROM OUTDOORS

Equation	Application	NFVA Requirements
3	All air from **outdoors**, using an *Upper-only* vent or duct	When **1 *Upper* opening** (or vertical or horizontal duct) provides the CVA: • The vent/duct must provide 1 sq. in. NFVA per 3,000 Btuh input. **NFVA in sq. in. = KBtuh ÷ 3** Note: The appliance must have clearances of 1" on sides and back and 6" in front. If non-conforming, this condition will need to be remedied by the addition of a conforming upper and lower duct.
4	All air from **outdoors**, using 1 Upper vent or *vertical* duct and 1 Lower vent or *vertical* duct	When **Upper & Lower vertical vents/ducts** provides CVA: • Each *vertical* (upper and lower) duct must provide **1 sq. in. NFVA per 4,000 Btuh input.** **NFVA in sq. in. = KBtuh ÷ 4**
5	All air from **outdoors**, using 1 Upper *horizontal* duct and 1 Lower *horizontal* duct	When **Upper & Lower horizontal ducts** provide CVA: • Each *horizontal* duct must provide 1 sq. in. NFVA per 2,000 Btuh input. **NFVA in sq. in. = KBtuh ÷ 2**
Note: Crawlspace vents with closable louvers shall not be included in the NFVA calculation.		

To calculate outdoor NFVA, use the Sections 11.7.4 through 11.7.5 below.

11.7.4 CALCULATE EXISTING OUTDOOR CVA

To calculate vent NFVA in sq. in., multiply Width X Height of the existing vent(s) in inches and apply the appropriate reduction factor from Figure 11.7.5. Compare the measured NFVA with how much NFVA is needed, to determine if the existing vent meets the requirement.

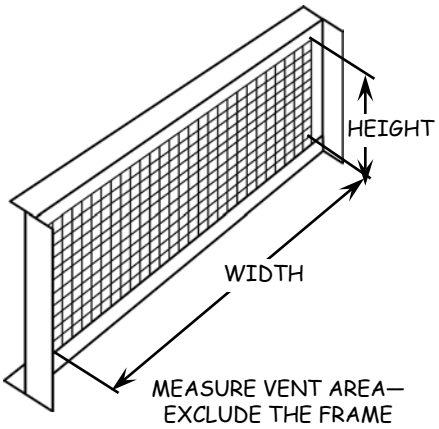
Use this equation:

(Required NFVA) – (Existing NFVA) = Additional NFVA Needed.

For upper-only vents or ducts, the NFVA must equal or exceed the sum of the vent connector cross-sectional areas.

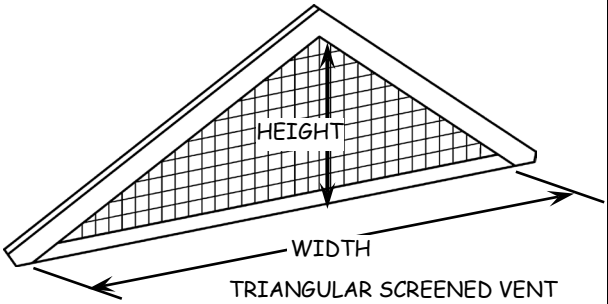
FIGURE 11.7.4 – MEASURING VENTS

1. **Rectangular Vents:** When measuring a vent, include only the louvered or screened area—the actual vent opening. Do not include any area occupied by solid frame material.



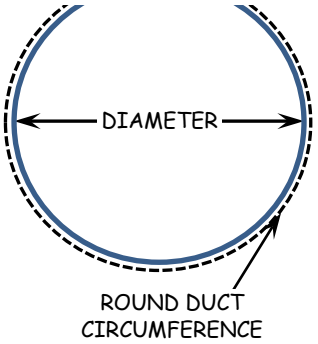
   - Measure the size of the vent opening (width and height in inches). For a louvered vent, that's the size of just the louvered part. For a screen-only vent, it's the open screen area (as shown in the graphic to the right).
   - Calculate the vent area using the equation: **(width in.) x (height in.) = vent area sq. in.**
     - Example: If the louvered or screened part of a vent is 10″ wide and 6″ high, it has a 60 sq. in. vent area.
     - Calculate NFVA, using the equation and Reduction Factor from Figure 11.7.5: **(vent area sq. in.) x (Reduction Factor) = NFVA sq. in.**
   - Note: If you ever need to convert sq. *in.* into sq. *ft.*, divide sq. in. by 144 (because there are 144 sq. in. in a sq. ft.).
     - Example 1: a 12″ x 12″ vent opening is 144 sq. in. (144 sq. in.) / (144) = 1 sq. ft.
     - Example 2: a 12″ x 6″ vent opening is 72 sq. in. (72 sq. in.) / (144) = 0.5 sq. ft.

2. **Triangular Vents:** Measure the actual vent opening (exclude the solid frame), using the equation below:



TRIANGULAR SCREENED VENT
WITH 1/4-INCH MESH

   - Calculate the triangular vent area using the equation: **(width in.) x (height in.) x (0.5) = vent area sq. in.**
   - Example: In the triangular vent to the right, the open part of a vent is 10″ wide and 6″ high, so it has a 30 sq. in. vent area (10″ x 6″ x 0.5 = 30 sq. in).
   - Calculate NFVA using the equation below and the Reduction Factor from Figure 11.7.5: **(vent area sq. in.) x (Reduction Factor) = NFVA sq. in.** With 1/4-inch mesh, the Reduction Factor is 0.90, so (30 sq. in. x 0.90) = **27 sq. in. NFVA.**



3. **Round Ducts and Vents:** The actual open area is also what is measured on round ducts and vents. Looking at the end of a *round duct or vent*, the area of the *opening* you see is the "round duct area".
   - For *round ducts*, begin by measuring the diameter (or circumference) of the duct.
     - The diameter is the distance across the open duct end.
     - The circumference is the distance around the outside of the duct.
   - On a *round vent*, measure the diameter of just the round vent opening, not the surrounding frame.
   - Use the diameter or the circumference in the table below to find the "round duct area" for common ducts sizes.
     - On the top row, find diameter of the duct (or vent opening on a round vent). Then move directly down to the center row to find the "round duct area"; or
     - On the bottom row, find circumference the duct, and then move directly up to the center row to find the "round duct area".

- For round vents, and for round ducts with louvers or mesh at the end, you must convert the "round duct area" to NFVA, by using the appropriate Reduction Factor in Figure 11.7.5.

AREA OF ROUND DUCTS

Duct Diameter (in.)	3"	4"	5"	6"	7"	8"	9"	10"
Round Duct Area (sq. in.)	**7.1**	**12.6**	**19.6**	**28.3**	**38.5**	**50.3**	**63.6**	**78.5**
Duct Circumference (in.)	9.4"	12.6"	15.7"	18.8"	22.0"	25.1"	28.3"	31.4"

- *What if the round duct or vent is an odd size not shown in the table?* To calculate the "round duct area" of any size duct (or vent), use this equation:
  - (3.1415) x (Diameter/2) x (Diameter/2) = round duct (or vent) area sq. in.

  Example*:* Assume the duct/vent diameter is 8.5".
  (3.1415) x (8.5" / 2) x (8.5" / 2) = 56.7 sq. in. round duct (or vent) area , which becomes:
  (3.1415) x (4.25) x (4.25) = 56.7 sq. in. round duct (or vent) area.

FIGURE 11.7.5 –APPLYING REDUCTION FACTORS

The "Reduction Factors" for screens and louvers in the Table below are used to finish your calculation of NFVA when a louver, mesh, or screen is present on the vent. The Reduction Factor represents the percentage (%) of the opening that is not blocked by louvers and/or screen—in other words, *the percentage of air that can freely pass through.* For example, if the wires in 1/4" mesh or screen take up 10% of the opening, and 90% of the opening remains unobstructed—so the Reduction Factor is 0.90.

1. Select the Reduction Factor
   - NFVA may be marked on the vent (on a sticker or stamped into the metal.
   - If purchasing a vent, you can use the NFVA data listed in the product literature.
   - When NFVA information is not available, you must:
     - Measure the vent opening, and
     - Calculate NFVA using the appropriate Reduction Factor from the table below.
   - Applying the Reduction Factor
     - Select the table that best describes the type of vent you are evaluating.
     - Use row (A) for vents that have mesh only.
     - Use row (B) for vents that louvers only or louvers and mesh.
     - Find the weave of the mesh you are evaluating.
     - The box directly below gives you the "Reduction Factor" for that mesh.
     - Then, multiply or divide by that Reduction Factor.

REDUCTION FACTORS FOR LOUVERS AND SCREENS

(A) Mesh Only	1/4" Mesh (hardware cloth)	1/8" Mesh (wire mesh)	1/16" Mesh (insect screen)
	0.90 (90%)	**0.75** (75%)	**0.50** (50%)

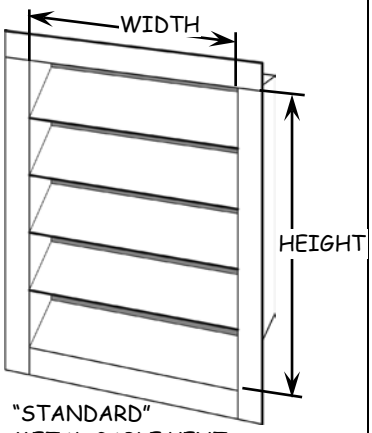
(B) Louvers & Mesh	Metal Louvers **or** Metal Louvers and 1/4" or 1/8" Mesh	Metal Louvers and 1/16" Mesh	Wood Louvers **or** Wood Louvers and 1/16" to 1/4" Mesh
	0.75 (75%)	**0.50** (50%)	**0.25** (25%)

- Note:
  - 1/4" mesh (wires spaced 1/4" apart) is found on newer metal vents, such as gable and foundation vents.
  - 1/8" mesh (wires spaced 1/8" apart), is commonly used on eave and soffit vents.
  - 1/16" weave (wires spaced 1/16" apart), used as window screen, shall not be used on CVA or attic vents (because it reduces airflow too much).

2. "Standard" Louvered Metal Vents

Louvers in "standard" CVA vents (e.g., factory-made transfer grilles, return grilles, or metal gable vents are a standard distance apart. The Reduction Factors in the table above are based on those louvered metal vents.

- The actual open space between the louvers is the NFVA, and is what is assumed in the Reduction Factor for "Metal Louvers".



"STANDARD"
METAL GABLE VENT—
REDUCTION FACTOR 0.75

"STANDARD"
WOODEN GABLE VENT—
REDUCTION FACTOR 0.25

Graphic Credit: RHA, Inc.

- If large openings between metal gable vent louvers have more than 75% free air space, follow steps below for NFVA of "Non-standard" Vents in Figure 11.7.6.

3. "Standard" Gable Wood Vents

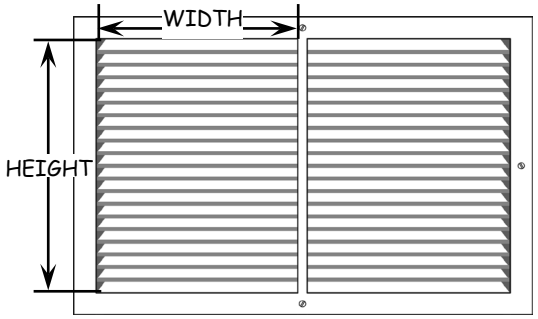
"Standard" wooden gable vents are factory made with standard thickness and spacing. For those, use the "Wood Louvers" fields in the Reduction Factor table.

- Measure only width and height of the part of the vent that has louvered openings (exclude the frame).
- If there is no airflow above it, measure to the bottom of the top louver.

4. NFVA for a Split CVA Vent

When a grille has a solid divider in the middle, as shown on the Return Grille to the right:

- Measure the vent area of each half. (Do not include area of the solid divider when present.)
- Add them together, and
- Multiply by the appropriate Reduction Factor to determine NFVA.



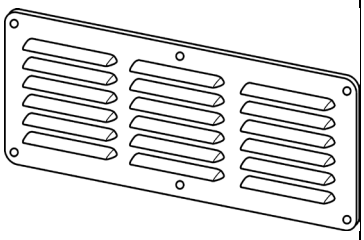
METAL RETURN GRILLE WITH CENTER DIVIDER: CALCULATE VENT AREA OF EACH SECTION, ADD THEM TOGETHER, AND MULTIPLY BY 0.75 TO FIND TOTAL

Graphic Credit: RHA, Inc.

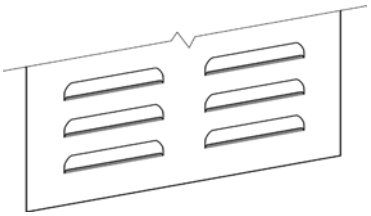
FIGURE 11.7.6 – NFVA FOR NON-STANDARD VENTS

Additional steps are required to determine their NFVA for non-standard vents (i.e., wider or narrower louver spacing). For these non-standard vents, alternative Reduction Factors must be used. Here are three examples:

- *Soffit Vents:* Soffit vent louvers are narrower than standard vents, and they are usually screened with 1/8" mesh—which must be replaced with 1/4" mesh when used for new outdoor CVA venting.
- *Metal Louvers for Water Heater Enclosure:* Sometimes seen on the sheet metal door of a mobile home enclosures —and on some factory-made water heater enclosures , they consist of a horizontal cut in the sheet metal and bending the metal upward to form a louver with non-standard spacing.
- *Non-standard"* wooden gable vents are field- or shop-fabricated, with very thick louvers (e.g., 1″ x 2″ boards) and/or odd spacing between them.



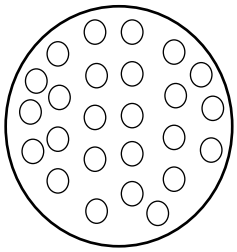
METAL SOFFIT VENT WITH NON-STANDARD LOUVERS AND 1/8-INCH MESH



NON-STANDARD LOUVERS ON METAL ENCLOSURE DOOR

For these non-standard louvered vents, calculate NFVA by:

- Measuring the size of the opening of one louver: **(length inches) x (height inches) = louver sq. in.**
- If no mesh is present, multiply this louver opening area by the number of louvers.
- If there is mesh behind louvers: (open area sq. in.) x (Reduction Factor) = NFVA sq. in.



"UNUSUAL METAL VENT"— FLAT METAL WITH HOLES

Unusual Metal Vents

- There is one more class of highly unusual CVA vents, such as:
  - Drilled metal—flat metal with holes drilled in it.
  - Stamped metal—flat metal with holes stamped (cut) in it.
  - Expanded metal—metal cut and pulled apart to create holes.
- You must *estimate* the NFVA, based on size and number of openings.
  - Measure the open area in 1 sq. in. of the vent, and multiply by the number of sq. in. of vent area, or
  - As a last option, use a "default" Reduction Factor of 0.50.

Table Graphics Credit: RHA, Inc.

11.7.5 CVA CALCULATION QUICK REFERENCE TABLE

To save time, use Table 11.7.5 on the following page to quickly determine CVA requirements without having to do math calculations.

- Column [A] lists several Btuh Input totals.
- Column [B] is used when CVA is based on indoor room volume.
- Column [C] gives minimum size of interior vents, when additional volume is needed from an adjacent space.
- Column [D] applies to an upper-only CVA vent or vertical duct.

- Column [E] applies when both upper and lower vents or vertical ducts are used.
- Column [F] applies when both upper and lower horizontal ducts are used.

The table below is a quick reference to determine room volume or CVA vent and duct size.

TABLE 11.7.5: CVA REQUIREMENTS FOR OPEN COMBUSTION GAS-BURNING APPLIANCES

OPEN COMBUSTION FURNACE AND/OR WATER HEATER IN A ROOM/SPACE	HOMES WITH INFILTRATION OF AT LEAST 0.40 ACH[3] WITH APPLIANCES LOCATED IN A CONFINED SPACE, AND ALL COMBUSTION AIR OBTAINED FROM INDOORS		ROOM OR SPACE WITH INADEQUATE VOLUME, AND ALL COMBUSTION AIR OBTAINED FROM OUTDOORS		
			[D] 1 Upper Opening (or 1 Vertical or Horizontal Duct) [4, 5, 6, 7, 8, 10] **[E]** 1 Upper Opening or **Vertical** Duct and 1 Lower Opening or Vertical Duct [6, 7, 8, 9, 10]		Two **Horizontal** Ducts [8, 10]
TOTAL INPUT	MIN. ROOM VOLUME	MIN. NFVA PER VENT	MIN. NFVA UPPER-ONLY VENT/VERTICAL DUCT	MIN. NFVA FOR EACH OF **2** VENTS/VERTICAL DUCTS	REQUIRED NFVA PER DUCT FOR **2** DUCTS
[A] BTUH	**[B] CU. FT.**	**[C] SQ. IN.**	**[D] SQ. IN.**[10]	**[E] SQ. IN.**[10]	**[F] SQ. IN.**
20,000	1,000	100	Rect: 9.0 • Rnd: 7.07	Rect: 9.0 • Rnd: 7.07	10.0
25,000	1,250	100	Rect: 9.0 • Rnd: 8.3	Rect: 9.0 • Rnd: 7.07	12.5
30,000	1,500	100	10.0	Rect: 9.0 • Rnd: 7.5	15.0
35,000	1,750	100	11.7	Rect: 9.0 • Rnd: 8.8	17.5
40,000	2,000	100	13.3	10.0	20.0
45,000	2,250	100	15.0	11.3	22.5
50,000	2,500	100	16.7	12.5	25.0
55,000	2,750	100	18.3	13.8	27.5
60,000	3,000	100	20.0	15.0	30.0
65,000	3,250	100	21.7	16.3	32.5
70,000	3,500	100	23.3	17.5	35.0
75,000	3,750	100	25.0	18.8	37.5
80,000	4,000	100	26.7	20.0	40.0
85,000	4,250	100	28.3	21.3	42.5
90,000	4,500	100	30.0	22.5	45.0
95,000	4,750	100	31.7	23.8	47.5
100,000	5,000	100	33.3	25.0	50.0
105,000	5,250	105	35.0	26.3	52.5
110,000	5,500	110	36.7	27.5	55.0
115,000	5,750	115	38.3	28.8	57.5
120,000	6,000	120	40.0	30.0	60.0
125,000	6,250	125	41.7	31.3	62.5
130,000	6,500	130	43.3	32.5	65.0
135,000	6,750	135	45.0	33.8	67.5
140,000	7,000	140	46.7	35.0	70.0
145,000	7,250	145	48.3	36.3	72.5
150,000	7,500	150	50.0	37.5	75.0
160,000	8,000	160	53.3	40.0	80.0

[3] For ACH *less* than 0.40, see Table 11.6.4.

[4] Just one opening (or one vertical or horizontal duct) in or beginning within 12" of the ceiling is allowed when the appliance has clearances of 1" on sides and back and 6" in front. Vent/duct NFVA must equal or exceed the sum of the vent connector areas.

[5] Combustion air must be obtained air from outdoors or from spaces freely communicating with outdoors.

[6] Attic must be adequately vented. Vent openings must be protected from ceiling insulation (e.g., with sleeve 6" above it).

[7] Vertical ducts must extend into unobstructed space, and may not be screened if terminating in the attic.

[8] Upper vent/duct shall be installed in the ceiling or within 12" of ceiling, and lower vent/duct shall be in the floor or begin within 12" of the floor. However, a pre-existing upper vent is acceptable at any location higher than the draft hood.

[9] Crawlspace must have free flow of air and unobstructed openings to outdoors that provide adequate crawlspace venting. Foundation vents should be screened with 1/4" mesh.

[10] The minimum cross-sectional dimension of CVA vents and ducts is 3". Minimum rectangular vent/duct is 3"x3" (**9.0 sq. in.**); minimum round vent/duct is 3" diameter (πr^2 = 3.1415 x 1.5" x 1.5" = **7.07 sq. in.**).

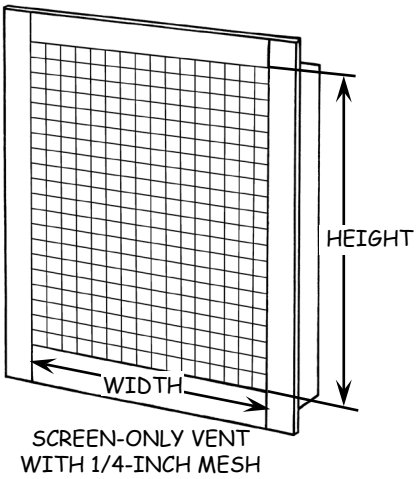
11.8 WHEN ADDITIONAL OUTDOOR CVA IS REQUIRED

When NFVA of existing outdoor CVA vents is not sufficient (in the amount identified in Table 11.7.3), additional NFVA must be added or the condition is a CAS Fail. Corrective action is required, or Section 5.1 of this appendix shall apply. Additional NFVA can be accomplished by enlarging existing vents, replacing small-weave mesh with 1/4" mesh, or adding vents to the space. Tables on the following pages describe the minimum requirements for obtaining CVA from outdoors.

11.8.1 VENT OPENING AREA FOR NEW CVA VENTS

To find out if a new vent will provide adequate NFVA, use this equation to determine the minimum sq. in. that the vent must be:

Required NFVA sq. in. ÷ Reduction Factor = Vent Area sq. in.



Graphic Credit: RHA, Inc.

- *Example:* You need a CVA vent that has 70 sq. in. NFVA. The vent has 1/4" mesh (reduction factor = 0.90).
  - Thus, (70 sq. in. NFVA) ÷ (0.90) = **77.8 sq. in.** screened **vent area** is required to provide **70 sq. in. NFVA**.
  - You could install a *rectangular* 12" x 10" vent with a 1" wide frame around a 10" x 8" screened vent area. 10" x 8" = **80 sq. in.** screened vent area.
  - You could also install a *round* screen-only vent with a diameter of 10 inches, which you see in Figure 11.7.4 has a **78.5 sq. in** round vent area**.**

11.8.2 MESH REQUIREMENTS FOR CVA VENTS AND DUCTS

- Vents to Outdoors
  - 1/4" mesh is required on all *new* CVA vents and ducts to outdoors ("quarter-inch hardware cloth"). *Exception*: Ducts that terminate in the attic shall not be screened on either end.
  - Vents exposed to precipitation (rain or snow) shall be louvered.
- Vents to Indoors
  - Mesh is not required on louvered vents between indoor areas, including CVA vents in the living space and vents for an appliance enclosure located inside a garage.
  - When present, unneeded mesh may be removed to increase NFVA.

11.8.3 TABLE: INSTALLATION CRITERIA FOR NEW CVA VENTS

This is an overview of size and location requirements for new CVA vents and ducts—first for conventional homes, and then for mobile homes.

INSTALLATION OF NEW CVA VENTING—CONVENTIONAL HOMES					
EXISTING LOCATION	**VENT SIZING**	**VENT TO ADJACENT SPACE/ROOM**	**NEW UPPER LOCATION**	**NEW LOWER LOCATION**	**ALTERNATIVE CORRECTION**
Indoor CVA	• 1 sq. in. NFVA for each 1,000 Btuh input, but a minimum of 100 sq. in. • When room volume is too small, install upper *and* lower CVA vents into adjacent room(s).	• Adjacent room(s) must be large enough to provide the required additional room volume.	• Top of vent must begin within 12" of the ceiling.	• Bottom of lower vent must begin within 12" of the floor.	• It is also possible to (a) replace a solid door with a louvered door; or (b) permanently remove a solid door. • Must get owner's prior written permission.
2 Vents to Outdoors– Upper & Lower **(Most common installation)**	• For vents or vertical ducts, each must provide 1 sq. in. NFVA per 4,000 Btuh input. • For horizontal ducts, each must provide 1 sq. in. NFVA per 2,000 Btuh input.	N/A	• Vent must be in the ceiling, or top of vent must begin within 12" of the ceiling. • Upper CVA shall not be ducted up from the crawlspace. • Ducts terminating in attic shall not be screened.	• Vent must be in the floor, or bottom of vent must begin within 12" of the floor. • A vertical duct can extend from the attic to within 12" of the floor. The ends shall not be screened.	N/A
1 Vent to Outdoors– -Upper Only	• 1 sq. in. per 3,000 Btuh NFVA, but not less than the total of the cross-sectional areas of all vent connectors in the enclosure. • The appliance must have at least: (a) 1" clearance on the sides and back, and (b) 6" clearance in the front.	N/A	• Vent must be in the ceiling or top of vent must begin within 12" of the ceiling.	N/A	N/A

INSTALLATION OF NEW CVA VENTING—MOBILE HOMES					
EXISTING LOCATION	**VENT SIZING**	**VENT TO ADJACENT SPACE/ROOM**	**NEW UPPER LOCATION**	**NEW LOWER LOCATION**	**ALTERNATIVE CORRECTION**
Mobile Home Water Heater: 2 Vents to Outdoors– Upper & Lower	• For vents or vertical ducts, each must provide 1 sq. in. NFVA per 4,000 Btuh input.	N/A	• When an upper vent is created by passing the appliance vent pipe through the center of a larger pipe, NFVA of the upper vent equals the area of the space between the outer and inner pipes.†	• Vent must be in the floor, or bottom of vent must begin within 12" of the floor.	• The upper vent can also be a louvered grille in outside wall. • The top of the grille must begin within 12" of the enclosure ceiling.
Mobile Home Water Heater: 1 upper-only vent to Outdoors	• This concept must be proposed when the permit is obtained from HCD. • If allowed, sizing shall be as prescribed by HCD (which could be the same as for conventional homes in the table above).	N/A	• The new upper vent shall be in compliance with HCD regulations. • If a pipe-within-a-pipe is allowed, see criteria in the box directly above.	N/A	• The upper vent can also be a louvered grille in outside wall. • The top of the grille must begin within 12" of the enclosure ceiling

† NFVA Calculations for mobile home water heater enclosure, when upper CVA vent is pipe-within-a-pipe:

- Measuring the diameter (or circumference) of each pipe.
- Obtain the "Pipe Area (sq. in.)" for each pipe from Figure 11.7.4.
- Subtract smaller pipe area from larger pipe area. The difference is the NFVA of the space between the two pipes.

Example: The inner pipe diameter is **3"** (7.1 sq. in. area), and the outer pipe in the CVA assembly diameter is **6"** (28.6 sq. in. area). NFVA of the space between them is 21.2 sq. in. NFVA of the upper CVA vent = (28.3 – 7.1) = **21.2 sq. in.**

11.9 COMBINATION-INDOOR & OUTDOOR CVA

Combination indoor and outdoor CVA venting (e.g., from the living space and from the attic or crawlspace) should be avoided and eliminated whenever possible, because the vent to outdoors creates a large, unwanted shell leak. For example, in some homes, the appliance enclosure in the hallway has a lower CVA vent in the door (taking air from the living space), and an upper CVA vent in the ceiling (open to the attic).

- The best practice is to seal off the vent in the door on the inside, and make sure the vent to the outdoors in the enclosure ceiling is the proper size for "upper-only" CVA.
- Also, installing CVA venting to indoors must be avoided, whenever practicable.

Step 4

LIVING SPACE AMBIENT CO TEST

REMEMBER: If any CAS Hazard or CAS Fail condition is identified that cannot be corrected:

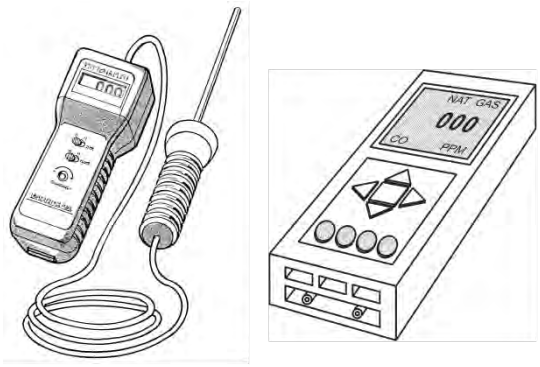
- (DOE Program or dwelling leveraged with DOE) The dwelling shall be DEFERRED.
- (LIHEAP) The dwelling shall be NIM (non-infiltration reduction measures) only.

12. Living Space Ambient Procedure

A living space ambient CO reading is taken to determine the operating safety for all SPACE HEATING units.

12.1 CO ANALYZER OPERATION

Operate the CO analyzer in "as-measured" mode (not "air-free"). The Analyzer shall remain ON during the entire ambient CO sequence, when possible. If turned off during testing, repeat the zeroing process before resuming ambient CO tests.



"ZEROED" CARBON MONOXIDE ANALYZERS

Graphic Credit: RHA, Inc.

12.2 TEST PROTOCOL

"Zero" the Analyzer outdoors; then perform and document two living space ambient readings in the CSD 700 form.

12.3 ZEROING OUTDOORS

- Just prior to measuring the *First* living space ambient CO reading, "zero" the CO Analyzer outdoors—as far away from CO sources as possible.
- Auto-Zeroing: Instruments that automatically self-zero shall be operated in accordance with manufacturer's instructions (e.g., outdoor reading will always be "000").
- Manual Zeroing:
  - A manually-adjusted CO Analyzer, which may have a reading of "±001" or greater when turned on outdoors, must be zeroed per manufacturer's instructions (e.g., it might be considered zeroed when the reading is "000" ± 005 PPM).
  - If the readout fluctuates (does not stabilize at 000), the highest number displayed is used as the "Outdoor Reading".
    - Example: If readings outdoors during the zeroing process are –001, 000, +003, +002, the highest (+003) is the "Outdoor Reading" (is considered to be "zero" PPM CO).
    - Living space ambient CO is calculated as illustrated in Tables 12.4.1 and 12.4.2.
- Location for zeroing shall be protected to the extent possible from outdoor sources of CO (e.g., people smoking, wood burning appliance exhaust, automobile and industrial exhaust) and from wind bearing such pollutants.

12.4 TESTING PROCEDURE

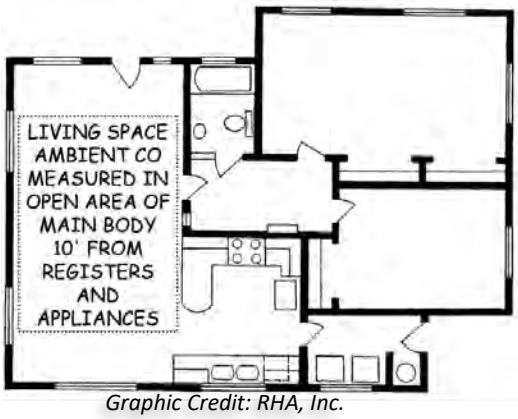
The FIRST living space ambient CO test shall be performed prior to operating any appliances.

- Test Conditions
  - All combustion appliances in the living space turned off (e.g., at the thermostat).
    - Pilots may be operating, but main burners shall be off.
    - Air handler and all exhaust fans and devices turned off.
    - Exterior doors and windows (prime and storm) closed.
  - Interior doors:
    - Appliance enclosure doors closed.

- All other interior doors open.
- Fireplace damper closed when feasible (no fire or hot coals).
- If an interior evaporative cooler vent cover is available, it shall be in place.

12.4.1 FIRST LIVING SPACE AMBIENT CO MEASUREMENT

- Immediately after zeroing the CO Analyzer outdoors (to obtain the "Outdoor Reading"), draw an air sample in a location meeting the following criteria:
  - In an open area in the main body of the living space (e.g., in the living room or living/dining combination area).
  - 10' away from combustion appliances and supply registers, or as far away as possible when less clearance is available.
  - 6' above the floor.



Graphic Credit: RHA, Inc.

- The difference (change) in CO PPM between the "zeroed" outdoor reading and living space reading is the *First* living space ambient CO level (see example in Table 12.4.1).
- FIRST Living Space Ambient CO Action Levels
  - When the *First* living space ambient CO is higher than 9 PPM—it is required to check for possible sources of CO indoors, such as the following[11]:
    - Smokers in the home.
    - Current or recent use of the cooktop and/or oven.
    - Over-gassed (oversized) pilot flame in a cooking appliance.
    - Unvented space heater being used in the home.
    - Wood-burning appliance used, burning candles, incense, etc.
    - Exhaust from idling vehicles in the attached garage or near a door or window into the home.
  - When a source of indoor CO is found, eliminate it if possible. Ventilate the home, then perform the SECOND Living Space Ambient CO Test (even if 10 PPM or greater after ventilation and repeat of First test).
  - Complete the remaining ambient CO test and the appliance flue and draft CO tests.

[11] Living space ambient CO more than 2 PPM above the "zeroed" Outdoor Reading *should* be investigated; but *must be* if 10 PPM or higher.

TABLE 12.4.1: FIRST LIVING SPACE AMBIENT CO TEST — SAMPLE CALCULATIONS

Procedure: With all appliances turned Off, compute the difference (change) in CO PPM between the "zeroed" Outdoor Reading* and the *First* Living Space Ambient CO reading. For example:

(A) If, when the CO Analyzer was turned on outdoors and zeroed*, the Outdoor Reading was "003" … but the *First* Living Space reading is "007" … the difference (change) is as follows:

- [Living Space reading (007)] minus [Outdoor Reading (003)],
- [007 – 003] = 004 (4 PPM *difference*), so
- *First* Living Space Ambient CO is 4 PPM. It does *not* exceed 9 PPM, so it is a "Pass".

(B) If, when the CO Analyzer was turned on outdoors and zeroed*, the highest Outdoor Reading was
"–003" … but the *First* Living Space reading is "+007" … the difference (change) is as follows:

- [Living Space reading (+007)] minus [Outdoor Reading (–003)],
- [(+007) – (–003)] = +010 (10 PPM *difference*), so
- *First* Living Space Ambient CO is 10 PPM. It does exceed 9 PPM, so it is a "Fail", and corrective action is required.

*If the CO Analyzer automatically self-zeros, the Outdoor Reading will always be "000". A manually-adjusted CO Analyzer, which may have a reading of "001" or higher when "zeroed" outdoors, must be zeroed per manufacturer's instructions.

12.4.2 SECOND LIVING SPACE AMBIENT CO

- Test Conditions
  - Operate a*ll space heating* appliances for at least 5 minutes.
  - All other combustion appliances and all exhaust fans and devices remain off.
  - All doors and windows remain as they were for the *First* living space ambient CO test.
  - If the CO analyzer was turned off following the initial test, zero it again outdoors.
- Procedure—SECOND Living Space Ambient CO
  - An air sample for the *Second* Living Space Ambient CO Test is drawn in the same location used for the *First* Living Space test.
  - The difference (change) in CO PPM between the "zeroed" Outdoor Reading and *Second* Living Space reading is the *Second* Living Space Ambient CO level (see examples in Table 12.4.2).
- SECOND Living Space Ambient CO Action Levels
  - If Ambient CO in the living space exceeds 9 PPM, corrective action is required.

TABLE 12.4.2: SECOND LIVING SPACE AMBIENT CO TEST — SAMPLE CALCULATIONS

Procedure: With *all Space Heating* appliances turned On (operating) for 5 minutes (all other appliances remain Off), compute the difference (change) in CO PPM between the "zeroed" Outdoor Reading* and the *Second* Living Space Ambient CO reading. For example:

(A) If the "zeroed" Outdoor Reading was "002" … but the *Second* Living Space reading is "008" … the difference (change) is as follows:

- [2nd Living Space reading (008)] minus [Outdoor Reading (002)],
- [008 – 002] = 006 (6 PPM *difference*), so
- *Second* Living Space Ambient CO is 6 PPM. It does *not* exceed 9 PPM, so it is a "Pass".

(B) If the "zeroed" Outdoor Reading was "–002" … and the *Second* Living Space reading is still "+008" … the difference (change) is as follows:

- [2nd Living Space reading (+008)] minus [Outdoor reading (–002)],
- [(+008) – (–002)] = +010 (10 PPM *difference*), so
- *Second* Living Space Ambient CO is 10 PPM. It does exceed 9 PPM, so it is a "Fail", and corrective action is required.

*If the CO Analyzer has not been turned off since the Initial test, it is not necessary to re-zero outdoors. Simply use the Initial "zeroed" Outdoor Reading.

Step 5

APPLIANCE AMBIENT CO TEST

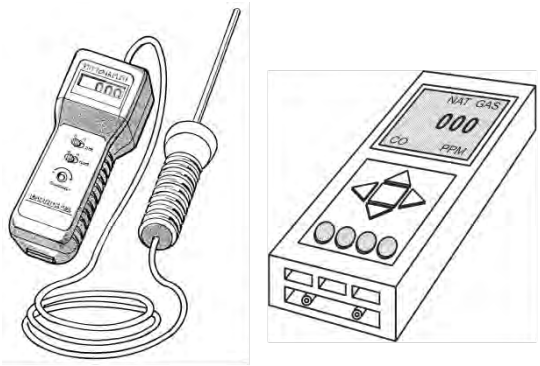
REMEMBER: If any CAS Hazard or CAS Fail condition is identified that cannot be corrected:

- (DOE Program or dwelling leveraged with DOE) The dwelling shall be DEFERRED.
- (LIHEAP) The dwelling shall be NIM (non-infiltration reduction measures) only.

13. Appliance Ambient CO Procedure

This test procedure measures CO put into the atmosphere by combustion appliances.

- It is required for all space heating appliances.
- It is performed on water heaters, when flue gas CO cannot be measured.
- It is not performed for solid-fuel appliances (wood- and pellet-burning stoves and fireplace inserts).



"ZEROED" CARBON MONOXIDE ANALYZERS
Graphic Credit: RHA, Inc.

Applicable water heating units are:

- ***Induced Draft Units***
  - When a test hole cannot be drilled in the pipe, and access to the flue termination is not feasible.
- ***Closed Combustion Units: When access to the flue termination is not feasible.***
- ***Indoor Tankless Water Heater Units***
  - Natural draft units when a probe or extension cannot be inserted inside the exhaust outlet; or
  - Induced draft and closed combustion units when access to the flue termination is not feasible.

13.1 CO ANALYZER OPERATION

Operate the CO analyzer in "as-measured" mode (not "air-free") for appliance ambient CO testing. Keep the Analyzer ON during the entire living space and appliance ambient CO test sequence, when possible. If turned off during testing, the zeroing process shall be repeated before resuming ambient CO tests.

13.2 TEST PROTOCOL FOR SPACE HEATING SYSTEMS

The test sequence requires the technician to perform the appliance ambient test for all gas space heating units, then document the reading(s) in the CSD 700 Form.

- Test Conditions and House Set-Up
  - This test shall *immediately follow* the *Second* living space ambient CO Test.
  - Operate all gas space heating appliances for at least 5 minutes.
  - All other combustion appliances and all exhaust fans and devices remain off.
  - All doors and windows remain as they were for the *First* living space ambient test.
  - Zero the CO analyzer outdoors again, if it was turned off after the ambient tests.
- Appliance Ambient CO Action Levels
  - CO Analyzer reading may stay the same, go down, or go up.[12]

[12] A change of 2 PPM or less is allowed, because small electronic "bounce" in the readout is common without measuring an actual change in CO concentration. If the appliance *is* leaking CO, the reading should increase more than 2 PPM.

TABLE 13.2.1: AMBIENT CO TESTING			
APPLIANCE	**APPLIANCE PREPARATION**	**TEST PROBE LOCATION**	**ACTION LEVELS (Maximum CO level before or after Service)**
Space Heating Systems	• Operate appliance for at least 5 minutes, except as noted. • Keep all other combustion appliances/exhaust fans off. • All doors and windows remain as they were for the 1st living space ambient CO test. • Zero the CO analyzer outdoors, if it was turned off after the initial ambient test.	• Ambient CO testing shall be performed before flue gas CO is measured. • Forced air units (FAUs) shall be checked for the presence of CO in the supply register nearest the furnace. Test probe is inserted into the register and directed into the airflow. • Heaters without ducts first shall be checked for CO in the atmosphere just above the heat exchanger (above top of the unit), then as prescribed below: - Wall furnaces: ▪ Test probe is placed just above the heat exchanger on both sides of draft hood inlet, or ▪ In the airflow of the built-in circulating fan, when present. - Floor Furnaces, Direct Vent, and Free-standing Heaters: Test probe is placed just above the top of the appliance.	• **Appliance Ambient** Action Level: CO maximum is 2 PPM above the 2nd Living Space Ambient CO reading. • If CO exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.
The Ambient Tests below apply only to induced draft and closed combustion *storage* water heaters, and to *indoor tankless* water heaters, when a flue gas CO measurement is not feasible (i.e., the flue termination is on the roof or sidewall, and cannot be accessed). For this protocol, See Table 13.2.1 below.			
***Indoor* Tankless Water Heaters**	• Operate tankless water heater for one minute. • Note: A hot water faucet or valve must be open and hot water running, to keep the burner on during CO testing.	• Place the probe just above the water heater, and • Indoor pipe joints, if present.	• **Appliance Ambient** CO maximum is 9 PPM. • If CO exceeds the Action Level and manufacturer requirements, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.
Storage Water Heaters	• Operate appliance for at least 5 minutes, except as noted. • Keep all other combustion appliances/exhaust fans off.	• When flue gas CO cannot be measured, and there is no access to the vent termination, perform an Appliance Ambient CO test.	• Appliance Ambient CO maximum is 9 PPM. • If CO exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or

TABLE 13.2.1: AMBIENT CO TESTING			
APPLIANCE	**APPLIANCE PREPARATION**	**TEST PROBE LOCATION**	**ACTION LEVELS (Maximum CO level before or after Service)**
	• All doors and windows remain as they were for the 1st living space ambient CO test. • Zero the CO analyzer outdoors, if it was turned off after the initial ambient test.	• Examples of "no access" to the flue termination include the following: - Roof climb not feasible (e.g., inaccessible or roofing is deteriorated). - Sidewall termination is not safely accessible. - Roof-mount furnace is on a tile roof. • Mobile home closed combustion flue not accessible due to awnings along both sides. • Place the probe just above the water heater (and inducer unit, if applicable), and • Indoor pipe joints, if present.	allowed under the program, Section 5.1 of this appendix shall apply.

Step 6

FLUE GAS CO TEST

REMEMBER: If any CAS Hazard or CAS Fail condition is identified that cannot be corrected:

- (DOE Program or dwelling leveraged with DOE) The dwelling shall be DEFERRED.
- (LIHEAP) The dwelling shall be NIM (non-infiltration reduction measures) only.

14. Flue Gas CO Test Conditions and Procedures

Flue gas CO testing shall be performed for all natural gas and LP gas (propane) appliances.

14.1 CO ANALYZER OPERATION

All Flue Gas CO test readings shall be taken "as-measured", unless the CO tester is equipped with a(n):

- "Air-free" feature/function.
- CO sensor and an O_2 sensor with an on-board calculator.
- Probe extension.

The CO tester shall be properly calibrated and zeroed in accordance with this CSD TRM Appendix. (Note: Keep the Analyzer ON during the entire living space and appliance ambient CO test sequence, when possible. If turned off during testing, the zeroing process shall be repeated before resuming ambient CO tests).

For this test, CO shall be measured in the locations described in Tables 14.4.1 through 14.4.3.

Clearing the CO Sensor*:*
Before turning off a CO tester at the end of the flue gas CO test(s), run it in fresh air until after the CO reading stops dropping, which allows the pump to push fresh air through the sensor and clear out residual CO. This is especially important after measuring high levels of CO (helps maintain sensor accuracy).

14.2 TEST LOCATIONS

Both "as-measured" and "air-free" flue gas CO measurements are taken in the same location, ahead of/free of dilution air. The difference is that when a CO tester is set to measure "air-free", the tester uses both the CO and O_2 sensor and performs a calculation that provides a more accurate "air-free" reading.

- Natural Draft Appliances: The flue gas sample is taken inside of the flue (away from, and before the introduction of dilution air into the draft hood).
- Closed Combustion Appliances: The flue gas sample is taken by inserting the probe or extension into the flue gases inside the vent terminal (and away from ambient air).

"Air-free" measurements shall NOT be taken for: 1) ambient CO readings, or 2) for flue gas CO readings for these gas appliances: clothes dryers, cooktops, or refrigerators.

Action Levels are provided in Section 18 of this appendix.

14.3 OPEN AND CLOSED DOOR TESTS

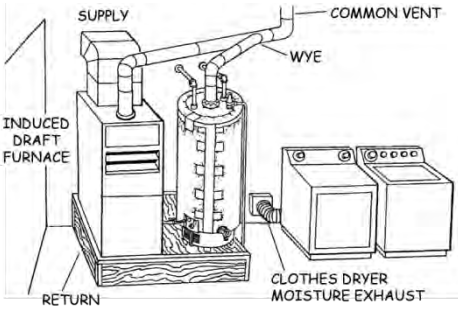
The flue gas CO tests must be performed with doors to the room or space containing the tested appliance both open and closed, with the results of each test recorded separately.

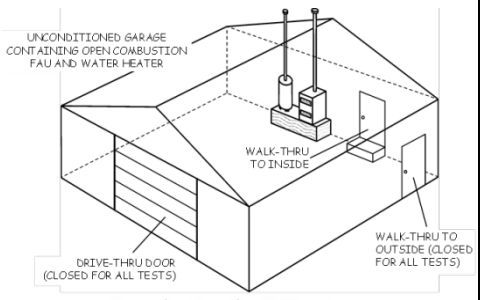
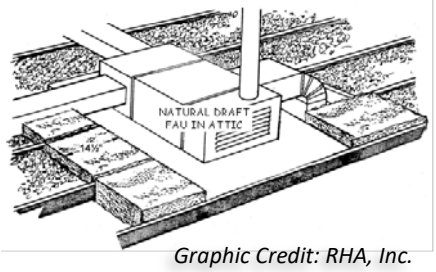
- When the enclosure is too small for a person to fit inside with the door closed, it is acceptable to do only the "Open Door" Test and circle "N/A" in the "Closed Door" box.
- Appliance CO checks shall be performed with doors to the space containing the tested appliance positioned as shown in Table 14.1.
  Note: Flue gas CO test conditions are the same for both Pre-CAS and Post-CAS tests.

MOBILE HOME TEST LIMITATIONS

- For **Mobile Homes**, roof access for CO testing is limited as follows:
  - The only type of mobile home roof that can be walked upon by weatherization crews is a sloping, wood-framed (e.g., truss) roof with continuous sheathing and roofing material in good condition (e.g., plywood sheathing covered with composition shingles or rolled roofing).
  - When a CO test is performed on a mobile home with a "flat" metal roof (flat or slightly sloping) on which climbing is not feasible or allowed:
    - A CO analyzer probe extension shall be used as needed to access the furnace vent termination without climbing on the roof.
- For **Mobile Homes**, CO tests in closed combustion vent pipes shall be achieved by:
  - Measuring flue gas CO inside the vent termination.
  - Using a probe extension as needed, to insert the end of the extension inside the vent pipe, to obtain a flue gas reading free of dilution air. The probe extension shall be long enough to reach the vent termination, and the end shall be bent sufficiently to reach inside the flue.
  - When flue gas cannot be measured (vent termination cannot be safely accessed), CO measurement is limited to an Appliance Ambient CO test.

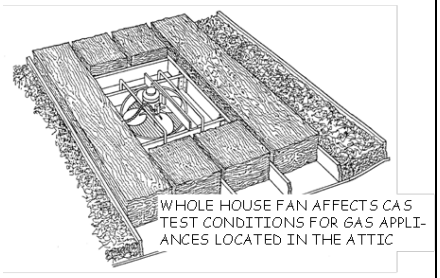
TABLE 14.1: INITIAL HOUSE SET-UP CONDITIONS FOR FLUE GAS CO TEST

Set-Up Condition	Action Prior to Testing
Standard Conditions	
Attic and Crawlspace— Access Door/Cover	• Close all attic and crawlspace access doors/covers during all CAS Testing, including tests of open combustion appliances located in the attic/crawlspace. • Perform only "Closed Door" tests, with access in the normal closed position.
FAU and Kitchen Exhaust Filters	• Clean or remove filter.
Clothes Dryer Lint Screen	• Clean lint screen.
Evaporative Cooler Vent Covers	• Cover discharge vents (when covers are available) or block vents.
Large Shell Leaks	• Block gaps/holes totaling 10 sq. in. or more that will be repaired. - Includes broken windows, glass, broken doors, and known holes in the envelope. Leaks may be blocked with tape, plastic, etc.
Multiple Appliances Sharing a Common Vent  *Graphic Credit: RHA, Inc.*	• When two appliances share a Common Vent, operate both appliances simultaneously during tests. • When a water heater that does not affect living space is commonly-vented with another unit that is not accessible, it is not necessary to operate the inaccessible unit during CAS tests. The cross-sectional area of the common vent pipe must equal the combined area of the vent connectors it serves. • Example: Area of two 3" pipes (2 x 7.1) = 14.2 sq. in., so they must vent into a 5" common vent (19.6 sq. in.). **Exceptions/Exclusions**: When CO in one appliance is sampled beyond the common vent wye, turn off the other appliance during that CO Test. Do when: • CO is checked at the vent termination of an Induced Draft Furnace, or • CO is measured in a test hole drilled in the common vent pipe beyond the wye.
Supply Registers	• Registers open. **Exceptions/Exclusions**: Close when located in a utility room, basement, etc. containing an open combustion appliance.
Exterior Doors/Windows	• Keep closed.
Appliance Enclosure Door	• Keep closed.
Closeable Hallways	• Open doors that close off the hallway from the main/open living areas. **Exceptions/Exclusions**: Close doors that close off the hallway from the main/open living areas only when: • Performing closed-door test on a wall furnace in the hallway, or • Performing closed- and open-door tests on an FAU or water heater in an enclosure with CVA vents to the hallway.
Doors to room containing an exhaust fan, when the door does not separate a supply register from a central return.	• Keep open.
Door to utility room with clothes dryer exhausted outdoors.	• Keep open. **Exceptions/Exclusions**: When a natural draft appliance in that room is being tested, the door is closed for the closed-door test.

Set-Up Condition	Action Prior to Testing
Door to Room with No Exhaust Fan	• Keep closed.
When a FAU is present…	• Close doors to rooms containing a supply register, when a central return is outside the room. Includes: - Bedroom/hallway door, when central return is in hallway. - Bedroom/hallway door, when both a supply register and a bathroom exhaust fan are present (bedroom/bathroom is open, and bathroom fan is on). - Bathroom/hallway door, when both a supply register and a bathroom exhaust fan are present (the bath fan is on).
Drive-thru door and garage windows	• Keep closed during all tests.
Door into Living Space	• *Closed* for closed-door tests—with air handler and exhaust devices located in the garage operating. • *Opened* for open-door tests—with air handler and exhaust devices in the living space and garage operating.  *Graphic Credit: RHA, Inc.* **Exceptions/Exclusions:** When a door from the garage into the living space is not present, an open-door test is not performed.
FAU Air Handler	• Operate air handler alone (without burner, when possible).
Combustion appliances that may affect the appliance being tested	• Operate other open combustion appliances located in, or drawing combustion air from, the same space.
Exhaust Fans/Devices	• Turn on kitchen and range hood exhaust fans, bathroom and utility room fans, clothes dryer, central vacuum system, and manually-controlled attic ventilators. • Do not operate whole house fan, (*except* as described near the end of this table for natural draft appliance present in attic). **Exceptions/Exclusions:** • Operation of air handler and exhaust fans/devices is not required, when CO testing a cooktop or oven not vented outdoors. • When: 1) a FAU and/or water heater are in an interior enclosure with solid door, and 2) all CVA venting is to *outdoors*, and 3) the door cannot be closed for CAS testing because the enclosure is too small, the air handler shall be on.
Natural draft water heater or FAU is present in the attic or crawlspace	• Turn off fans that increase pressure in the space (e.g., kitchen or bathroom fans exhausting directly into attic or crawl space). • Turn on manually-controlled fans that decrease pressure in the space (e.g., exhaust fans).  *Graphic Credit: RHA, Inc.*

<table>
<tr><th>Set-Up Condition</th><th>Action Prior to Testing</th></tr>
<tr><td>Pre-Wx CAS Test Conditions for Natural Draft Appliances Located in the Attic</td><td>

Exhaust fans that affect pressure in the attic shall be on during Tests.
CO and Draft Tests shall be performed with the whole house fan turned off, and repeated with the whole house fan turned on at high speed.
The worse of the two CO and Draft test results shall be recorded in the CSD 700.



Graphic Credit: RHA, Inc.
</td></tr>
<tr><td>If Appliance Fails CAS with Whole House Fan Operating</td><td>

Check for adequate NFVA, per this Appendix and manufacturer recommended exhaust ventilation for the fan.
If attic exhaust is less than 90% of recommended NFVA, additional venting must be installed to recommended NFVA, if feasible.
After Attic venting NFVA is increased, CAS Testing shall be repeated for the affected appliance(s).

<u>Exceptions/Exclusions</u>: When fan manufacturer's recommendation for attic exhaust ventilation is not available, these defaults may be used:

the table below, or by using this equation:
Min. Attic Exhaust NFVA sq. ft. = Fan CFM / 750. [13]
<u>Note</u>: Infiltration-reduction measures shall <u>not</u> be installed if:

Increased attic NFVA is needed but cannot be installed, <u>or</u>
An appliance in the attic still fails after attic NFVA is increased.

<table>
<tr><th colspan="4">WHOLE HOUSE FAN NFVA EXHAUST GUIDELINES</th></tr>
<tr><th>FAN CFM (AT HIGH SPEED)</th><th>MIN. ATTIC EXHAUST NFVA (SQ. FT.)</th><th>FAN CFM (AT HIGH SPEED)</th><th>MIN. ATTIC EXHAUST NFVA (SQ. FT.)</th></tr>
<tr><td>1,000</td><td>1.3</td><td>3,600</td><td>4.8</td></tr>
<tr><td>1,200</td><td>1.6</td><td>4,200</td><td>5.6</td></tr>
<tr><td>1,600</td><td>2.1</td><td>4,800</td><td>6.4</td></tr>
<tr><td>2,000</td><td>2.7</td><td>5,400</td><td>7.2</td></tr>
<tr><td>2,400</td><td>3.2</td><td>6,000</td><td>8.0</td></tr>
<tr><td>3,000</td><td>4.0</td><td>6,500</td><td>8.7</td></tr>
</table>
</td></tr>
</table>

[13] Fan CFM may be obtained from a label on the fan, the owner's manual, or from the fan manufacturer (e.g., online).

14.4 FLUE GAS CO TESTS BY APPLIANCE TYPE

Record test results in the CSD 700 Section that applies to the appliance being tested.

TABLE 14.4.1: NATURAL DRAFT OPEN COMBUSTION APPLIANCE—CO TESTING

APPLIANCE	APPLIANCE PREPARATION	TEST PROBE LOCATION	ACTION LEVELS (Maximum CO level before or after Service)
Furnace or Space Heater	Operate burner for 5 minutes before test.	• Perform Appliance Ambient CO tests as prescribed for a space heater in Section 13. • Insert probe or extension into the exhaust port(s) inside the draft hood. Check *each* exhaust port on multi-burner units, and *record each reading separately*. • When there is a baffle present (e.g., in a wall furnace), check CO on both sides of the baffle and *record the higher number*. • Note: If there is no access for flue gas measurement, CO Test is limited to Appliance Ambient CO for a space heater.	• CO Action Level for FAUs (all types), Direct Vent Wall Furnaces, and Floor Furnaces: Flue gas CO maximum is 100 PPM. • CO Action Level for Natural Draft Wall Furnace: 50 PPM • If CO exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.
Storage Water Heaters	Operate burner for 5 minutes before test.	• Insert the probe extension down into the center tube in combustion gasses free of dilution air. Check on both sides of the baffle, and *record the higher number*. • If there is no access for flue gas measurement, perform an Appliance Ambient CO Test.	• CO Action Level for water heaters *other than* Natural Draft, CO Action Level is 100 PPM. • CO Action Level for Natural Draft Water Heater Taking Air from the Living Space: Flue gas CO maximum is 50 PPM. • If CO exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.
Tankless Water Heaters—Indoors	Take CO reading after at least one-minute warm-up, with hot water running and the burner operating.	• Leave appliance cover on. • Use a L-shaped probe extension, if needed, to measure CO free of dilution air. • If there is no access for flue gas measurement, perform an Appliance Ambient CO Test in accordance with Section 13.	• CO Action Level: Flue gas CO maximum is 100 PPM. • If flue gas CO exceeds the Action Level, corrective action is required by a qualified technician. • If flue gas CO measurement is not feasible, perform an Appliance Ambient CO Test. (Ambient test Action Level = 9 PPM). • After service: Action Level or as specified by manufacturer.

TABLE 14.4.1: NATURAL DRAFT OPEN COMBUSTION APPLIANCE—CO TESTING			
APPLIANCE	**APPLIANCE PREPARATION**	**TEST PROBE LOCATION**	**ACTION LEVELS (Maximum CO level before or after Service)**
Tankless Water Heaters—Outdoors	Take CO reading after at least one-minute warm-up, with hot water running and the burner operating.	• Leave appliance cover on. • Flue gas CO shall be checked inside the exhaust outlet. • Draft test and appliance ambient CO test are not applicable.	• Flue gas CO Action Level: 100 PPM (or as specified by manufacturer). • If flue gas CO measurement is not feasible, or if flue gas CO exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply. • After service: Action Level or as specified by manufacturer. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.
Clothes Dryer	• Lint filter shall be clean. • Drum may be left "as found" (i.e., may contain clothes) during the CO test; however, if CO exceeds the Action Level, empty drum & recheck. • Measure CO after 30 seconds of burner operation (burner is lit); may cycle off quickly when drum is empty.	• Insert the probe or extension inside the moisture exhaust termination, or • If lint screen is accessed from the top of the dryer, insert the probe/extension deep into the lint screen cavity (near the bottom). Be careful to not hit the fan blade. • Appliance ambient test is not required.	• CO Action Level: maximum 100 PPM. • If CO exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply. • As a non-essential appliance, a malfunctioning unit may be abandoned with client permission to correct a fail condition (i.e., flexible gas connector removed and line (shutoff) valve capped or line valve removed and the line capped).
Cooking Appliance—Cooktop Burners	• With oven and broiler burners off, operate each cooktop burner separately for at least 15 seconds. • If griddle is present, operate griddle for at	• The air handler, kitchen exhaust, and other exhaust devices in the home shall be off during test of the cooktop. • Set burner at the highest setting, with the grate in place (Note: Clean grate if very dirty/greasy). • Hold probe approximately 12" above the flame (positioned horizontally, not pointing into flame).	• CO Action Level: maximum 100 PPM. • If CO exceeds 100 PPM after 15 seconds, burner may be operated longer (e.g., up to a minute) and retested. • If CO exceeds the Action Level, corrective action is required by a qualified technician. If correction is

TABLE 14.4.1: NATURAL DRAFT OPEN COMBUSTION APPLIANCE—CO TESTING			
APPLIANCE	**APPLIANCE PREPARATION**	**TEST PROBE LOCATION**	**ACTION LEVELS (Maximum CO level before or after Service)**
	least 5 minutes before taking CO reading.	• If a griddle is present, insert probe inside the port opening, with the griddle in place.	not feasible or allowed under the program, Section 5.1 of this appendix shall apply.
Cooking Appliance—Oven and Broiler Cooking Appliance—Oven and Broiler (cont.)	• With cooktop and broiler off, operate the oven burner on highest "Bake" setting for a minimum of 5 minutes. • When a separate broiler burner is present, operate on "Broil" setting for 5 minutes (with oven burner off).	• The air handler, kitchen exhaust, and other exhaust devices in the home shall be off during test of the oven/broiler. • Insert probe into oven exhaust termination (on a range, usually located at back of cooktop). • For ovens *vented outdoors:* (a) Test ahead of where dilution air is added, or (b) block dilution air inlet and insert probe or extension inside the vent termination outdoors. • For convection ovens, measure CO in convection mode (fan on) and then in standard mode (fan off), and *record the higher reading*.	• CO Action Level maximum is 200 PPM. • If CO exceeds 200 PPM after 5 minutes, warm up time shall be increased (up to 30 minutes), and unit shall be re-tested. • If CO exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.
Cooking Appliance with Space Heater or Incinerator	• The heater/incinerator shall be operated for a minimum of 5 minutes on the highest burner setting.	• If the heater/incinerator is not vented outdoors, the home is NIM. • For a heater/incinerator vented outdoors, measure flue gas CO in the exhaust stream ahead of dilution air. • When a draft hood is present, measure CO in the exhaust port inside the draft hood. • When there is no draft hood, measure CO: - Inside the vent termination, or - Inside a CO test hole in the vent pipe. (Drill test hole, then seal.) • Note: Appliance Ambient CO test is required, as prescribed above for a space heater.*	• CO Action Levels for a heater/incinerator vented outdoors: CO maximum is 100 PPM. • If CO exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply. • If heater/incinerator is not vented outdoors, Section 5.1 of this appendix shall apply.
Gas Log	• Operate gas burner for a minimum of 5 minutes before checking CO.	• When the gas log is the primary heat source: - The damper must be blocked partially open (e.g., with a damper clamp) sufficiently to prevent spillage. - If it is not possible to adequately open the damper, the home is NIM, until the damper is brought into conformance.	• CO Action Level maximum is 40 PPM. • If CO exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.

TABLE 14.4.1: NATURAL DRAFT OPEN COMBUSTION APPLIANCE—CO TESTING			
APPLIANCE	**APPLIANCE PREPARATION**	**TEST PROBE LOCATION**	**ACTION LEVELS (Maximum CO level before or after Service)**
	• If CO exceeds maximum after 5 minutes, increase warm-up time up to 30 minutes and retest (Note: concrete logs require longer warm-up than ceramic logs).	• When glass doors are present, they shall be fully open during all tests. • To measure "flue gas" CO, place probe *just inside* the top edge of the fireplace opening, holding probe horizontally. Do not place the probe inside the fireplace (fire box) or point it downward toward the flame. - Appliance ambient CO test is not required. • When gas log is not the primary heat source, and the damper is not blocked partially open: - Educate occupants about the need to keep the damper open when the gas log is operating. - Document education [e.g., note in CSD 700].	• When a non-essential appliance, a malfunctioning unit may be abandoned to correct a fail condition (i.e., flexible gas connector removed and line (shutoff) valve capped or line valve removed and the line capped).
Gas Fireplace (Free-Standing or Fireplace Insert)	• Operate unit for 5 minutes before test.	• Measure Appliance Ambient CO as prescribed for a space heater. • Measure flue gas CO inside the dilution air intake, with the probe extension directed downward into the flue (as you would into a water heater center tube). • If there is no access for flue gas measurement, CO Test is limited to Appliance Ambient CO.	• CO maximum is 100 PPM. • If CO exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.

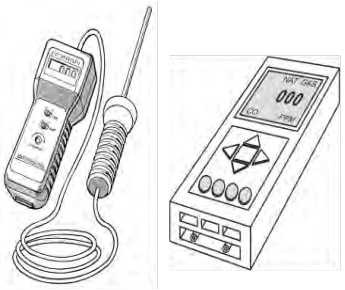
TABLE 14.4.2: INDUCED DRAFT OPEN COMBUSTION APPLIANCE—CO TESTING			
APPLIANCE	**APPLIANCE PREPARATION**	**TEST PROBE LOCATION**	**ACTION LEVELS (Maximum CO level before or after Service)**
Furnace or Space Heater	• Operate burner for 5 minutes before test. • Note: Drill a test hole in an induced draft appliance vent pipe to measure flue gas CO(also use for draft test). • Drill hole as feasible, when the vent termination cannot be safely accessed. - Follow test hole instructions in Section 15.	• Perform Room and Appliance Ambient CO tests as prescribed for a space heater in Sections 12 & 13. • To measure flue gas CO, insert probe/extension inside the vent termination on the roof (or the sidewall, if horizontal). • When roof climb is not feasible, or sidewall termination cannot be reached, use a 1/4" OD aluminum probe extension (up to 10' long) when allowed by the tester manufacturer. • When termination cannot be reached, but drilling a test hole is feasible per Section 15 requirements, insert probe into the test hole. Seal hole after test. • If there is no access for flue gas measurement, CO Test is limited to Appliance Ambient CO for a space heater.*	• CO Action Levels: - Appliance Ambient CO maximum is 9 PPM. - Flue gas CO maximum is 100 PPM. • If flue gas CO measurement is not feasible, or if flue gas CO exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.
Storage Water Heaters	• Operate burner for 5 minutes before test.	• Insert probe inside the vent termination. • When termination cannot be reached, but drilling a test hole is feasible in accordance with "Draft Test" section requirements, insert probe into the test hole. Seal hole after test. • If there is no access for flue gas measurement, perform an Appliance Ambient CO Test as in Section 13.2.	• CO Action Levels: - Appliance Ambient CO maximum is 9 PPM. - Flue gas CO maximum is 100 PPM. • If flue gas CO measurement is not feasible, or if flue gas CO exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.

TABLE 14.4.3: CLOSED COMBUSTION (DIRECT VENT) APPLIANCE—CO TESTING			
APPLIANCE	**APPLIANCE PREPARATION**	**TEST PROBE LOCATION**	**ACTION LEVELS (Maximum CO level before or after Service)**
Furnace or Space Heater	• Operate natural gas or LP burner for 5 minutes before test.	• Perform Room and Appliance Ambient CO tests as prescribed for a space heater in Sections 12 & 13. • Insert probe/extension in exhaust outlet at the vent termination, or sidewall if horizontal (e.g., on the roof for a mobile home FAU, or on the sidewall for a direct vent wall furnace). • If there is no access for flue gas measurement, CO Test is limited to Appliance Ambient CO for a space heater.*	• CO Action Levels: - Appliance Ambient CO maximum is 9 PPM. - Flue gas CO maximum is 100 PPM. • If flue gas CO or Appliance Ambient exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.
Storage Water Heaters	• Operate natural gas or LP burner for 5 minutes before test.	• Insert the probe extension down into the center tube in combustion gasses free of dilution air. Check on both sides of the baffle, and *record the higher number*. • If there is no access for flue gas measurement, perform an Appliance Ambient CO Test in accordance with Section 13.	• CO Action Levels: - Appliance Ambient CO maximum is 9 PPM. - Flue gas CO maximum is 100 PPM. • If flue gas CO or Appliance Ambient exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.
Tankless Water Heaters—<u>Indoors</u>	• Take CO reading after at least one-minute warm-up, with hot water running and the burner operating.	• Leave appliance cover on. • Insert probe/extension: - Inside the vent termination, free of dilution air, <u>or</u> - At the manufacturer's test port, if present and accessible (e.g., in the exhaust collar). • If there is no access for flue gas measurement, perform an Appliance Ambient CO Test in accordance with Section 13.	• CO Action Levels: - Appliance Ambient CO maximum is 9 PPM. - Flue gas CO maximum is 100 PPM. • A flue gas CO measurement shall be taken at the vent terminal. If not feasible, an appliance ambient test is required. If the test exceeds the appropriate Action Level, corrective action is required by a qualified technician. • If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.
Tankless Water Heaters—<u>Outdoors</u>	• Take CO reading after at least one-minute warm-up, with hot water running and the burner operating.	• Measure flue gas CO inside the vent termination. • Draft test and appliance ambient CO tests are <u>not</u> applicable.	• Flue gas CO maximum Action Level is 100 PPM (or as specified by manufacturer).

TABLE 14.4.3: CLOSED COMBUSTION (DIRECT VENT) APPLIANCE—CO TESTING			
APPLIANCE	**APPLIANCE PREPARATION**	**TEST PROBE LOCATION**	**ACTION LEVELS (Maximum CO level before or after Service)**
			• If flue gas CO at the termination exceeds 100 PPM, but the appliance does not "affect living space", no action is required. • If appliance affects the living space and flue gas CO at the termination exceeds the Action Level, corrective action is required by a qualified technician. • If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.
Direct Vent Gas Fireplace (Free-Standing or Insert)	Operate unit for 5 minutes before test.	• Measure Appliance Ambient CO as prescribed for a space heater. • Measure CO in the exhaust outlet at the vent termination. • If there is no access for flue gas measurement, CO Test is limited to Appliance Ambient CO.	• CO Action Levels: - Appliance Ambient CO maximum is 9 PPM. - Flue gas CO maximum is 100 PPM. • If flue gas CO exceeds the Action Level, corrective action is required by a qualified technician. If correction is not feasible or allowed under the program, Section 5.1 of this appendix shall apply.

14.5 APPLIANCE AMBIENT PROCEDURE FOR WATER HEATERS WHEN FLUE GAS CO TEST IS NOT FEASIBLE

This test applies only to induced draft and closed combustion *storage* water heaters, and to *indoor tankless* water heaters, when a flue gas CO measurement is not feasible (i.e., the flue termination is on the roof or sidewall, and cannot be accessed). For this protocol, see Section 14.3 of this Appendix.



Graphic Credit: RHA, Inc.

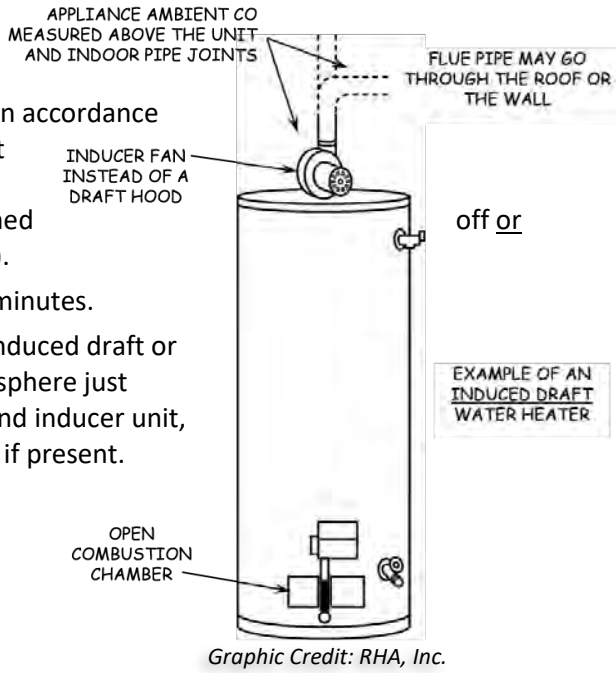
14.5.1 CO ANALYZER OPERATION

Operate the CO analyzer in "as measured" mode (not "air-free"). Keep the Analyzer on during the entire living space and appliance ambient CO test sequence, when possible. If turned off during testing, repeat the zeroing process before resuming ambient CO tests.

14.5.2 TEST PROTOCOL

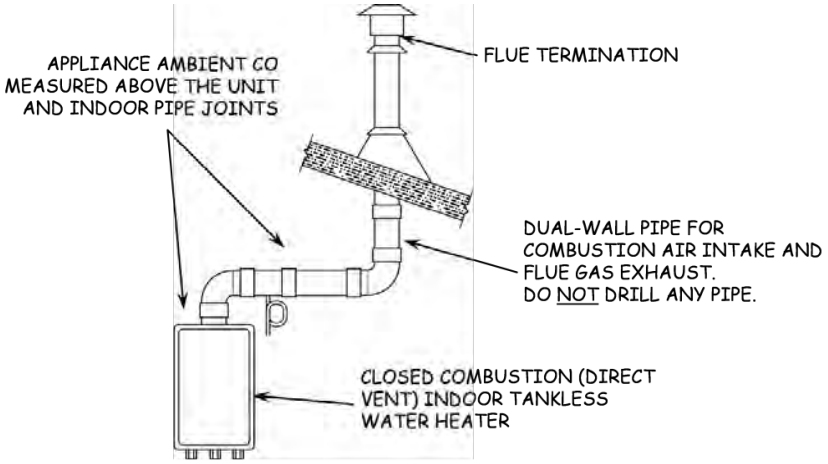
The test sequence requires the technician to perform the appliance ambient test for qualifying water heating units, then document the reading in the CSD 700 Form, with a notation that it is an ambient CO reading.

- Test Conditions
  - The Water heater being tested must be operating.
  - All other combustion appliances and all exhaust fans/devices are turned off.
  - For indoor units, doors and windows are set as prescribed for the *First* living space ambient CO test.
- Appliance Ambient CO Procedure for Storage Water Heaters
  - Obtain a "zeroed" Outdoor Reading in accordance with the living space ambient CO test procedure. (Note: "Zero" the CO analyzer outdoors again if it was turned off or it was used for a flue gas CO reading).
  - Operate burner for a minimum of 5 minutes.
  - Measure appliance ambient CO for induced draft or closed combustion units in the atmosphere just above the top of the water heater (and inducer unit, if applicable), and indoor pipe joints, if present.



Graphic Credit: RHA, Inc.

- Appliance Ambient CO Procedure for Tankless Water Heaters (indoor units only)
  - Burner shall be operated for a minimum of 1 minute.
    (Note: To activate burner and keep it on for the test, a hot water faucet must be open with hot water running).
  - All other gas appliances shall remain off.
  - CO shall be measured in the atmosphere just above the top of the water heater, and indoor pipe joints, if present.
- Appliance Ambient CO Action Levels
  - These special appliance action levels apply to both storage and tankless water heaters.
  - If Appliance ambient CO is higher than 9 PPM, infiltration-reduction measures shall not be installed until after the unit is checked / serviced by a qualified technician and is operating safely per manufacturer's specifications.



Graphic Credit: RHA, Inc.

Step 7

DRAFT & SPILLAGE CHECKS

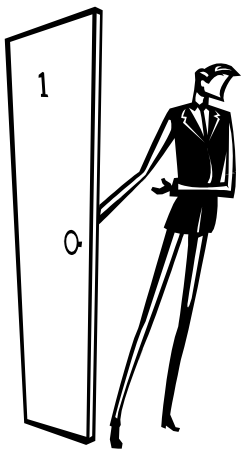
REMEMBER: If any CAS Hazard or CAS Fail condition is identified that cannot be corrected:

- (DOE Program or dwelling leveraged with DOE) The dwelling shall be DEFERRED.
- (LIHEAP) The dwelling shall be NIM (non-infiltration reduction measures) only.

15. Draft and Spillage Checks

There are three types of draft checks for open combustion appliances:

- Instrumented (Measured) Draft test—Performed on all natural draft appliances when feasible, and on induced draft appliances when a CO test hole was drilled.
- Visual Draft Test—Performed when instrumented test is not possible or for interim CAS test.
- Spillage Checks—Performed on all natural draft appliances.



15.1 OPEN AND CLOSED DOOR DRAFT TESTS

When possible, draft tests must be performed with doors to the room or space containing the tested appliance both open and closed, with results from each test recorded separately.

- When the enclosure is too small for a person to fit inside with the door closed, perform only the "Open Door" Test, and circle "N/A" in the "Closed Door" box.
- Confined Area/Hallway: For an appliance in a confined area that can be closed off completely with doors (e.g., wall furnace or appliance enclosure in a hallway that can be closed off from kitchen, living room, etc.):
  - "Closed Door" Test: all hallway doors closed.
  - "Open Door" Test: hallway door(s) open to a common area.

15.2 APPLIANCE SET-UP

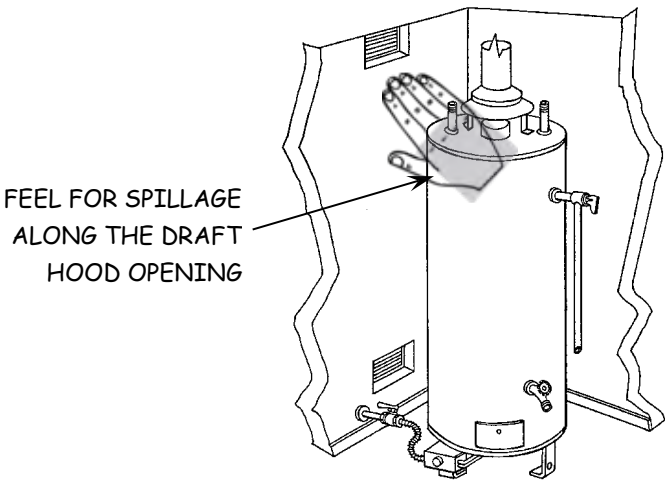
Operate gas burners for 5 minutes before performing the Instrumented Draft Test and Visual Draft Test, *except* as individually noted in the test procedures on the following pages.

For the Spillage Check, the gas burners must be operated as noted below:

- Within 2 minutes of main burner operation for a "warm vent", and
- Within 5 minutes of main burner operation for a "cold vent".

"Cold vent" exists when an appliance heat setting has been set to OFF. "Warm vent" exists for an appliance when the heat setting is turned to ON and the appliance has been operating.

Water heaters are *always* tested using a "warm vent" time requirement.

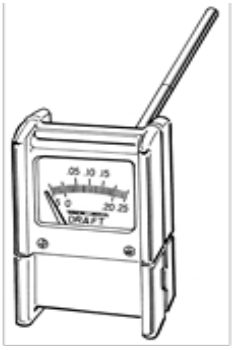


15.3 INSTRUMENTED (MEASURED) DRAFT TEST

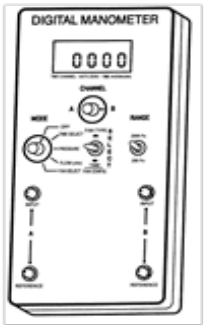
An Instrumented Draft Test is required only as described in Table 15.3 below, using: a draft gauge, the draft function on a CO tester, or a digital Manometer (gauge from Duct Blaster or Blower Door), as pictured at the right.

TABLE 15.3: INSTRUMENTED DRAFT TEST BY APPLIANCE AND WHEN REQUIRED

Combustion	Appliance Type	Instrumented Draft Test—When Required
Natural Draft Open Combustion	FAU/Space Heater, Storage Water Heater, and Vented Oven	Perform when a test hole can be drilled.
	Indoor Tankless Water Heaters	Perform when a test hole can be drilled. (Instrumented Draft Test is not feasible for all other tankless types.)
Induced Draft Open Combustion	FAU/Space Heater and Storage Water Heater	Draft test is only required when a flue gas CO test hole is drilled because CO measurement is not feasible at the vent termination (see Table 13.1.2). If the flue gas CO reading is accessible, drilling a hole just for a Draft Test is not required.
Closed Combustion	FAU/Space Heater and Storage Water Heater	An instrumented draft test is not applicable (draft test holes shall not be drilled).



DRAFT GAUGE
(READS IN IWC)



DIGITAL MANOMETER
(READS IN PASCALS)

Graphic Credit: RHA, Inc.

15.4 INSTRUMENTED DRAFT TEST PROCEDURES

TABLE 15.4.1 –INSTRUMENTED DRAFT TEST FOR OPEN COMBUSTION APPLIANCES (*except Tankless Water Heaters*)

1.	Correct draft hood defects.	If draft hood is misaligned or missing, or if multiple draft hoods are present, the condition shall be corrected before the draft test.
2.	Measure outside temperature in the shade and record.	Measure the outside temperature in the shade. When instrumented draft tests are performed at different times of day, recheck outdoor temperature each time and note on the CSD 700 form.
3.	Drill test hole for Instrumented Draft Test. 	• Drill test hole in a straight section of metal vent pipe: - Natural Draft: 12" to 24" beyond the draft hood opening - Induced Draft: Approximately 36" beyond the Inducer Fan (Drill induced draft vent pipe only when needed and feasible for CO Test, *not* for Draft Test only). • Hole diameter: - For all pipes: Appropriate for the test probe and plug button, but no larger than necessary (e.g., 5/16" for 1/4" outside diameter [OD] probe). - For B-vent (if not prohibited by pipe manufacturer): The outer hole is slightly larger, to facilitate application of high-temperature (e.g., RTV) silicone to seal the inner hole. It is sized to fit available plug buttons. • The test hole shall not be drilled in: - An elbow, or a loose or improperly-secured pipe. - Pipe for a mechanical draft system under positive pressure (e.g., stainless steel pipe with sealed joints). - Flexible pipe (i.e., ribbed flexible aluminum vent connector). - Asbestos-based pipe (e.g., “transite” pipe). - Double-wall or B-vent metal pipe, if drilling will void pipe warranty, or is prohibited by local code.

TABLE 15.4.1 –INSTRUMENTED DRAFT TEST FOR OPEN COMBUSTION APPLIANCES (*except Tankless Water Heaters*)

<table>
<tr>
<td>4.</td>
<td>Measure appliance drafting.</td>
<td>Use approved instrument to measure appliance draft (i.e., draft gauge, CO tester, digital manometer).

Insert tester probe through the test hole, to the center of vent pipe.
Draft is adequate and the appliance “passes” draft, only when negative pressure reading inside the vent pipe equals or exceeds the values shown in the table below.
A reading that is not negative/low enough is a CAS Fail, and is a Hazard Fail when spillage is also present. See “Corrective Action” below.

MINIMUM ACCEPTABLE DRAFT
Based on the Building Performance Institute (BPI) Standard.
<table>
<tr><th>OUTDOOR TEMP</th><th>IWC MINIMUM</th><th>PA MINIMUM</th></tr>
<tr><td>Below 31°F</td><td>–0.008 IWC</td><td>–2.00 Pa</td></tr>
<tr><td>31°F to 40°F</td><td>–0.007 IWC</td><td>–1.75 Pa</td></tr>
<tr><td>41°F to 50°F</td><td>–0.006 IWC</td><td>–1.50 Pa</td></tr>
<tr><td>51°F to 60°F</td><td>–0.005 IWC</td><td>–1.25 Pa</td></tr>
<tr><td>61°F to 70°F</td><td>–0.004 IWC</td><td>–1.00 Pa</td></tr>
<tr><td>71°F to 80°F</td><td>–0.003 IWC</td><td>–0.75 Pa</td></tr>
<tr><td>Above 80°F</td><td>–0.002 IWC</td><td>–0.50 Pa</td></tr>
</table>

A draft gauge is usually calibrated in “inches of water column” (iwc). A digital manometer is usually read in Pascals (Pa). A CO Tester with Draft function may read in either iwc or PA.
Negative pressures are affected by the outdoor temperature, which is why a temperature reading is required.

</td>
</tr>
<tr>
<td>5.</td>
<td>Plug draft test hole.</td>
<td>Following the Instrumented Draft test, the test hole must be sealed as described below.

Single-Wall Pipes:

Shall be capped with a snugly-fitting plug button.
May be additionally sealed with UL listed metallic tape, and/or with high-temperature non-hardening sealant (e.g., 450°F RTV red silicone).

</td>
</tr>
</table>

TABLE 15.4.1 –INSTRUMENTED DRAFT TEST FOR OPEN COMBUSTION APPLIANCES (*except Tankless Water Heaters*)

		• Double-Wall Pipes—Method A (Recommended only when allowed by Type B Manufacturers): - Insert the nozzle of a small tube of RTV silicone through the larger outer hole. - Apply enough caulk to seal the inner hole with a glob of the silicone. - Seal the outer hole with a properly-sized plug button. • Double-Wall Pipes—Method B (Alternative when allowed by Type B Manufacturers): - Apply high temperature RTV silicone caulk to the threads of a tight-fitting stainless steel bolt. - Size bolt to cover the larger outer hole and extend maximum 3/8" into the inner pipe. - Ensure that RTV silicone is on the portion of threads that extends into the inner pipe.
6.	Corrective Action	When Draft is not adequate, corrective action by a qualified technician is required. If correction is not feasible or not allowed under the program, Section 5.1 of this appendix shall apply.

***TABLE 15.4.2* -- INSTRUMENTED DRAFT TEST FOR *TANKLESS* WATER HEATERS ONLY**

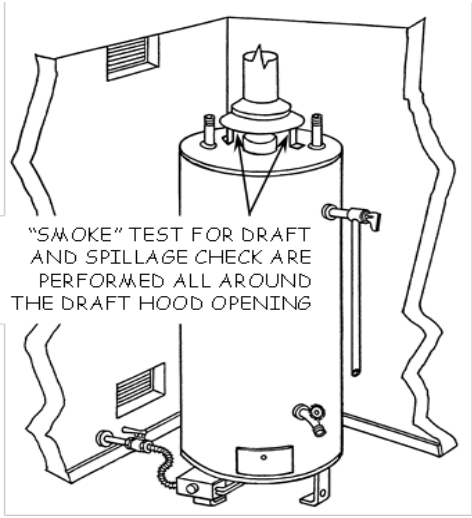
1.	Ensure that front cover is in place.	Front cover may be removed to read the nameplate, but it shall be in place during all appliance-on tests.
2.	Operate appliance.	Operate appliance for a minimum warm-up of one minute. You must run hot water to operate the burner during tests.
3.	Drill test hole for Instrumented Draft Test.	Instrumented Draft Tests are not feasible for the following Tankless Water Heater Types: • Induced draft (power vent) units; • Open combustion outdoor units; and • Direct vent (closed combustion) indoor and outdoor units. Perform an Instrumented Draft Test for open combustion indoor tankless water heaters: • Drill test hole in a straight section of metal vent pipe within 24" above the unit in a straight length of pipe, when not prohibited by the manufacturer or local code. • Note: The test hole shall not be drilled in: - Any sealed mechanical draft system vent pipe that is under positive pressure (e.g., Category III stainless steel pipe with sealed joints). - An elbow, or a loose or improperly-secured pipe. - Flexible pipe (i.e., ribbed flexible aluminum vent connector). - Asbestos-based pipe (e.g., "transite" pipe). - Double-wall or B-vent metal pipe, if drilling will void pipe warranty, or is prohibited by local code. • Hole diameter: - For all pipes: Appropriate for the test probe and plug button, but no larger than necessary (e.g., 5/16" for 1/4" outside diameter [OD] probe). - For B-vent (if not prohibited by pipe manufacturer): The outer hole is slightly larger, to facilitate application of high-temperature (e.g., RTV) silicone to seal the inner hole. It is sized to fit available plug buttons.  *Graphic Credit: RHA, Inc.*
4.	Measure Draft.	• Use an approved instrument to measure appliance draft. Draft is adequate and the appliance "passes" draft, only when negative pressure inside the vent pipe equals or exceeds the values shown in **Table 14.4** (or manufacturer's specifications, if different).

		• Inadequate draft is a Fail, and is a **Hazard Fail** when accompanied by spillage. Fails shall be addressed per Item 6: "Corrective Action" below.
5.	Plug draft test hole.	Following the Instrumented Draft test, the test hole must be sealed as described below. • Single-Wall Pipes: - Shall be capped with a snugly-fitting plug button. - May be additionally sealed with UL listed metallic tape, and/or with high-temperature non-hardening sealant (e.g., 450°F RTV red silicone). • Double-Wall Pipes—Method A (Recommended only when allowed by Type B Manufacturers): - Insert the nozzle of a small tube of RTV silicone through the larger outer hole. - Apply enough caulk to seal the inner hole with a glob of the silicone. - Seal the outer hole with a properly-sized plug button. • Double-Wall Pipes—Method B (Alternative when allowed by Type B Manufacturers): - Apply high temperature RTV silicone caulk to the threads of a tight-fitting stainless steel bolt. - Size bolt to cover the larger outer hole and extend maximum 3/8" into the inner pipe. - Ensure that RTV silicone is on the portion of threads that extends into the inner pipe.
6.	Corrective Action	When Draft is not adequate, corrective action by a qualified technician is required. If correction is not feasible or not allowed under the program, Section 5.1 of this appendix shall apply.

15.5 VISUAL DRAFT CHECK

A Visual Draft Test shall be performed on natural draft appliances, *when an Instrumented Draft Test is not feasible*.

***TABLE 15.5.1* -- VISUAL DRAFT TEST FOR NATURAL DRAFT SPACE HEATERS AND WATER HEATERS**

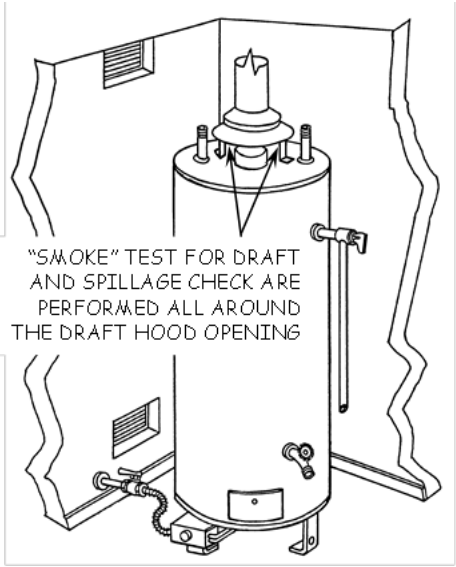
1.	Apply smoke around draft hood opening.	Perform a Visual Draft Test only when an Instrumented Draft Test is not feasible (e.g., a proper test hole cannot be drilled). • Note: A Visual Draft Test shall not be used in the place of a feasible Instrumented Draft Test. • Apply smoke along the entire draft hood opening, near the top of the opening. - Use a smoke "puffer", smoke "pencil", incense stick, an extinguished match, etc. Smoke from lighted match or cigarette is not acceptable. - Open flames at the draft hood can cause unburned fuel in the vent to explode. - Light tester 2 feet away from the appliance, extinguish the flame, and then place the smoking tester near the draft hood opening. • Draft is adequate only if smoke is drawn into the entire draft hood opening, and is, and continuous spillage is not present. - If the smoke is consistently drawn inward, the appliances "passes" draft testing. - If not, see the listed "Corrective Action" below in Item 5.  *Graphic Credit: RHA, Inc.*

VISUAL DRAFT TEST FOR <u>ALL OTHER APPLIANCES</u>		
2.	**Tankless Water Heaters**	**When an Instrumented Draft Test is not feasible:** • Draft shall be checked by applying "smoke" along the entire dilution air intake, if it is located directly outside the draft hood. • Open Combustion <u>Indoor</u> Tankless Water Heater - If a dilution air intake is not located in the front cover directly outside the draft hood (i.e., dilution air is drawn from the bottom or elsewhere in unit), Visual Draft Test is not feasible. - Draft is adequate only if smoke is drawn into the opening.
3.	**Gas Logs**	Perform a Visual Draft Test with glass doors open, if present. • Fireplace damper shall be open (or blocked partially open, if applicable). • Apply "smoke" along the entire top of the fireplace (lintel) at the edge of the opening. • Draft is adequate only if smoke is drawn inward along the entire fireplace opening. If inadequate, the corrective action policy shall apply.
4.	**Gas Fireplaces/ Inserts**	Perform a Visual Draft Test • Apply "smoke" along the edge of the dilution air intake opening. • Draft is adequate only if smoke is drawn inward along the entire dilution air intake opening. • If draft is inadequate and accompanied by spillage, the corrective action policy shall apply.
CORRECTIVE ACTION FOR ALL APPLIANCES		
5.	Appliance is <u>Not</u> Drafting Properly.	• If draft is inadequate, it is considered a CAS Fail, or a CAS Hazard when accompanied by spillage. Corrective action by a qualified technician will be required or TRM Appendix A, item 5.1 will apply.

15.6 SPILLAGE CHECK

A Spillage Check shall be performed on all natural draft appliances.

***TABLE 15.6.1* -- SPILLAGE CHECK FOR NATURAL DRAFT SPACE HEATERS AND WATER HEATERS**

1.	Check for spillage around entire draft hood opening.	• Perform a Spillage Check on all natural draft appliances. • Using the back of the hand, a small mirror, or smoke generator, move along/around the entire draft hood opening. • Spillage is present when warm moisture is felt on the hand, or there is fogging on the mirror, or smoke is pushed away from the opening: - At 2 minutes of main burner operation for a warm vent, and - At 5 minutes of main burner operation for a cold vent. • If spillage is continuous (e.g., not caused momentarily by gusts of wind), the condition is a **Hazard Fail** and shall be addressed as described in Item 2: "Corrective Action" below.  *Graphic Credit: RHA, Inc.*
2.	Corrective Action.	When: • Instrumented or Visual Draft Tests indicate draft is not adequate, and/or • Spillage Check indicates unacceptable spillage is present, then… Corrective action by a qualified technician is required. If correction is not feasible or not allowed under the program, Section 5.1 of this appendix shall apply.

Step 8

COMBUSTION APPLIANCE ZONE (CAZ) TESTING

REMEMBER: If any CAS Hazard or CAS Fail condition is identified that cannot be corrected:

- (DOE Program or dwelling leveraged with DOE) The dwelling shall be DEFERRED.
- (LIHEAP) The dwelling shall be NIM (non-infiltration reduction measures) only.

16. Summary of CAZ Test Procedures

A series of Combustion Appliance Zone (CAZ) Tests is required, when at least one of the appliances below is present in a dwelling.

- In CONVENTIONAL Homes where:
  - A solid-fuel appliance draw combustion air from the living space.
- In MOBILE Homes—when combustion air is drawn from the living space by any of the following:
  - Open combustion gas/oil furnace.
  - Open combustion gas/oil water heater.
  - Solid-fuel stove or stove insert (wood, pellet, or coal-burning).

16.1 OVERVIEW OF STEPS YOU WILL TAKE TO PERFORM THE CAZ PROCEDURE

CAZ testing consists of the 4 steps listed below. The house must be "set up" for each step; then the Combustion Appliance Zone (CAZ) procedure related to that house set-up will follow.	
1.	Measure "Baseline Pressure" in the CAZ. That is the pressure in the building cause by natural atmosphere conditions (wind, stack effect, chimney effect, etc.). The set-up of the house is in Section 16.3 and the Baseline Test procedure is in Section 16.4.
2.	Determine "Worst Case" CAZ Pressure. In this step, you will measure CAZ pressure under each of three test conditions: A, B, and C. Each condition requires you to "Smoke the Doors" as described in the shaded box to adjust the house set-up and take a new reading. Condition B and Condition C are only required when the home has a FAU.
3.	Evaluate the Worst Case Condition. For *each* "condition", you compare the measured CAZ pressure with the House Depressurization Limit (HDL). The HDL is the most a CAZ can be depressurized and still be considered safe for the type of appliance in the CAZ. See the HDL Table in Section 16.9 (Table 16.9.1).
4.	Determine whether corrective action is needed. Correction will be required when the CAZ is depressurized *more than* the HDL (is more negative). Possible corrections are listed in Sections 16.10 and 16.11.

16.2 WORKSHEET FOR RECORDING CAZ TESTING DATA

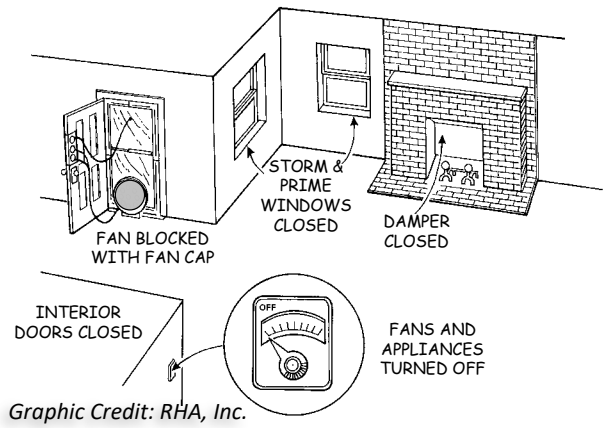
As you are performing the CAZ tests, the data must be recorded in the worksheet below. This data is tracked by the field personnel who are performing the CAZ procedures. Each of the test results from the following CAZ procedures shall be recorded here and worksheet kept in the client's file.

TABLE 16.2.1: CAZ WORKSHEET

PRESSURE READINGS:	**PRE (before shell sealing)**	**POST (after shell sealing)**
BASELINE PRESSURE: (Circle – or +)	• _____ Pascals – +	• _____ Pascals – +
TEST CONDITION A: Take CAZ pressure reading with exhaust fans on only.	• _____ Pascals – +	• _____ Pascals – +
TEST CONDITION B: Take CAZ pressure reading with exhaust fans and FAU air handler on.	• _____ Pascals – +	• _____ Pascals – +
TEST CONDITION C: Take CAZ pressure reading with air handler on only.	• _____ Pascals – +	• _____ Pascals – +
Are any of the pressure readings "more negative" than the HDL?	❑ No. Corrective action is not required. ❑ Yes. Corrective action is required.	❑ No. Corrective action is not required. ❑ Yes. Corrective action is required.

16.3 SET UP THE HOUSE FOR "BASELINE" TESTING

1. Close windows and all entrance and all interior doors, including the one to FAU enclosure.
2. Close passive inlet vents and install cooler vent covers, if available.
3. Close room air conditioner outside air inlet or install vent cover, if available.
4. Fully open all supply registers, *except* any in the Furnace room (which are closed).
5. Clean dirty filters, including the clothes dryer lint screen and the FAU return air filter. Remove filter, if cleaning or replacement is not possible. Check dryer exhaust for blockage at the termination.
6. Turn off all exhaust fans and devices. That includes kitchen exhaust, bath and utility room fans; mechanical ventilation fan, clothes dryer, whole-house vacuum system, manually-controlled attic vent fans, etc. Exclude the whole-house fan.

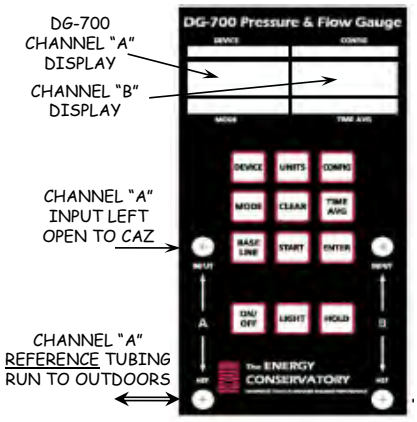


Graphic Credit: RHA, Inc.

7. If present, and if feasible to do so, close (a) the Fireplace damper and glass doors, or (b) Wood Stove/Insert air intake controls.
8. If a blower door is set up, install the "no-flow" plate and/or fan cap.
9. Turn off the furnace, water heater, and any other combustion appliances.

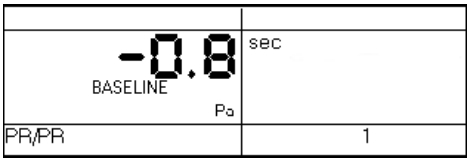
16.4 MEASURE BASELINE PRESSURE IN THE CAZ

After establishing conditions described above in Section 16.2, use the following procedure and a digital Manometer to measure the pressure difference between the CAZ and the outdoors. For each appliance zone that must be tested, set up the digital gauge to measure the "Baseline Pressure", which is the pressure difference between the CAZ and outdoor reading.

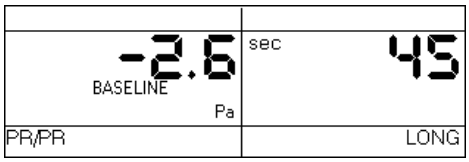


Graphic Credit: Energy Conservatory

1. Locate the manometer near the appliance for which CAZ testing is being performed.
2. Leave Channel "A" Input tap open, with the gauge in the zone near appliance being tested.
3. Run tubing from Channel "A" Reference tap to outdoors.
    - To improve accuracy when windy, use a wind dampener and extend the tubing to a wind-protected location.
4. Turn the Manometer on and leave it in the PR/PR mode (as shown in the graphic to the right).

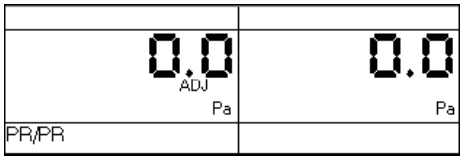


5. Press the BASELINE button.
6. The word "BASELINE" will begin to flash in the Channel "A" display (indicating the Baseline feature is activated). Channel "A" is reading the Baseline Pressure, and the Channel "B" display is inactive.
7. Press START button to begin the Baseline measurement procedure on Channel "A".



    - When the START button is pressed, "BASELINE" stops flashing and the gauge shows a long-term average Baseline Pressure reading on Channel "A".
    - While baseline pressure is measured, Channel "B" display is a timer to indicate how long (in seconds) the Baseline measurement is active.
    - The longer the measurement time, usually the more stable the Baseline reading becomes. The graphic shows the measured Baseline Pressure is –2.6 Pa (measured over the past 45 seconds).

5. After the Baseline Pressure reading is stable, press ENTER key to accept and enter the Baseline Pressure reading.
    - After pressing ENTER, Channel "A" will display the Baseline *adjusted* pressure reading (current Channel "A" pressure *minus* the baseline pressure).



- The "ADJ" icon appears under the Channel "A" pressure reading, to indicate that it is the "Baseline Adjusted" pressure reading.
- Time averaging will revert to the time averaging period that was being used before the BASELINE button was pushed.

8. Record the Baseline Pressure reading in the CAZ Worksheet (Table 16.2.1).

16.5 SUMMARIZING THE "WORST CASE" PROCEDURE

The test procedures described in Sections 16.6, 16.7, and 16.8 will allow you to calculate: (a) what the CAZ pressure is, (b) whether it is negative (–) or positive (+), and (c) whether it exceeds the House Depressurization Limit (HDL). If CAZ pressure is too negative (exceeds the HDL), corrective action will be required. You will measure CAZ pressure by applying the test procedures shown in Table 16.5.1 below.

TABLE 16.5.1: CAZ "WORST CASE" PROCEDURES

TEST CONDITIONS ➔ WHAT YOU DO ⬇	**Condition "A":** ***Exhaust Fans Only***	**Condition "B":** ***Exhaust Fans + Air Handler***	**Conditions "C":** ***Air Handler Only***
Where do you stand?	In the CAZ, near the appliance being tested.		
Where do you hold the gauge?	Channel "A" Input is held near the appliance being tested.		
Is there tubing on Channel "A" Input Tap?	No. The Channel "A" Input tap is left "open".		
Is there tubing on Channel "A" Reference Tap?	Yes. The Channel "A" Reference tap has tubing attached that goes outdoors.*		
*Run Channel "A" Reference tubing through the smallest possible opening. If a door or window is used, the remaining gap is taped closed. If the blower door is set up, tubing can be run through a tubing hole in the door panel. If it is windy out, install a wind dampener and place outdoor end of tubing in a sheltered location.			

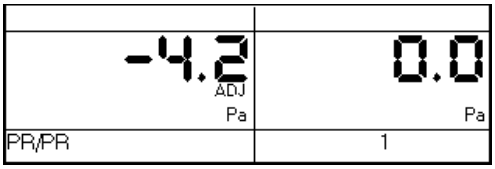
16.6 WORST CASE TEST CONDITION A – EXHAUST FANS ONLY

1. Ensure house and digital gauge are set-up as they were in Sections 16.3 and 16.4.

2. Turn on all exhaust fans/devices, including mechanical ventilation exhaust system or HRV/ERV that were turned off for the baseline measurement (air handler remains off).

3. Smoke the doors (follow procedure in shaded box on the following page).

4. Re-measure the pressure difference between the CAZ and outdoors and record the result in Table 16.2.1.



- In the screen to the right, Channel "A" shows the CAZ depressurization in this condition is –4.2 Pa. In other words, the CAZ was *depressurized* 4.2 Pa by the exhaust fans/devices when they were turned on.

- If the pressure reading on Channel "A" fluctuates too much, use a longer Time Averaging period.

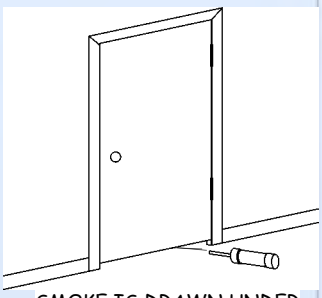
5. Record Worst Case Test Condition A in the CAZ Worksheet (Table 16.2.1).

6. Next Steps

   - If the home has an FAU, go to Worst Case Test Condition B and then Test Condition C.
   - If there is no FAU, only Condition A testing is required for each CAZ.

SMOKING THE DOORS

- For each of the "Worst Case" test conditions, you are required to "Smoke the Doors" to determine the set-up for the **interior** doors.
  - Standing in the main body of the home (e.g., a central hallway), squirt smoke under the door to each room containing an exhaust fan—except the CAZ (room) that is currently being tested.
    - If the smoke goes into the room, open the door.
    - IF the smoke comes back toward you, keep the door closed.
  - From the main body of the home, how squirt smoke under the CAZ door.
    - If smoke goes into the CAZ, keep the door closed.
    - If smoke comes back toward you, open the door.



SMOKE IS DRAWN UNDER THIS BEDROOM DOOR, SO IT WILL BE OPENED

Graphic Credit: RHA, Inc.

16.7 WORST CASE TEST CONDITION B – AIR HANDLER & EXHAUST FANS

1. Maintain house and digital gauge set-up, and keep exhaust fans/devices on (operating).

2. Turn on the air handler—fan only (without burner) when possible, and on highest speed when the air conditioner is re-set.

3. "Smoke the doors" again, as described in the shaded box above. Set interior doors accordingly.

4. Re-measure the pressure difference between the CAZ and the outdoors, and record it in the CAS Worksheet (Table 16.2.1).

16.8 WORST CASE TEST CONDITION C – AIR HANDLER ONLY

1. Maintain house and digital gauge set-up, and keep the air handler on (operating).
2. Turn off all exhaust fans/devices and the mechanical ventilation system that were turned on in Condition A.
3. Again "Smoke the doors", as described in the shaded box on the previous page. Set interior doors accordingly.
4. Re-measure the pressure difference between the CAZ and the outdoors, and record the results in the CAZ Worksheet (Table 16.2.1).

16.9 EVALUATE THE "WORST CASE" CONDITION

1. Identify which of the "Worst Case" conditions causes the greatest negative "CAZ reading.
2. Compare that pressure with the appropriate "House Depressurization Limit" (HDL) in Table 16.9.1 below.
3. If there are two or more combustion appliances in the CAZ, check the HDL for each appliance type, and use the HDL that is *most negative*.
4. If the negative pressure in the CAZ exceeds the HDL, corrective action is required. See Sections 16.10 and 16.11.

TABLE 16.9.1: HOUSE DEPRESSURIZATION LIMIT (HDL)**

PART 1—GAS- AND OIL-FIRED APPLIANCES	HDL (MAX. DEPRESS.)
Natural Draft Water Heater only	–2 Pa
Natural Draft Water Heater and Natural Draft Furnace/Boiler (common vent)	–3 Pa
Natural Draft Water Heater and *Induced* Draft Furnace/Boiler (common vent)	–5 Pa
Natural Draft Furnace/boiler only	–5 Pa
Induced Draft Furnace/Boiler only	–15 Pa

PART 2—SOLID FUEL APPLIANCES	HDL (MAX. DEPRESS.)
Standard Fireplace* (unlined chimney on exterior wall)	–3 Pa
Standard Fireplace* (metal lined, insulated, or interior chimney)	–4 Pa
Standard Wood Stove or Fireplace Insert (not EPA-Certified & "Airtight")	–3 Pa
Controlled-Combustion EPA-Certified "Airtight" Wood Stove or Fireplace Insert drawing combustion air from the living space	–5 Pa
Controlled-Combustion EPA-Certified "Airtight" Wood Stove or Fireplace Insert drawing combustion air from outdoors (e.g., "Mobile Home" type)	–10 Pa
Pellet Stove, with exhaust fans and sealed vents	–15 Pa

*Open combustion Fireplace without sealed glass doors and/or restricted air intake.

**Some test procedures, the HDL table, and the Manometer display graphic are adapted from the Minneapolis Blower Door Operating Manual, and are used with permission from the Energy Conservatory.

16.10 PRESSURE BALANCING PROCEDURE WHEN FAU IS PRESENT

This procedure must be performed when the home has a central return and the "Worst Case" CAZ pressure is more negative than the HDL. Use it to determine if any room with a solid door is restricting return air enough to require pressure relief to balance return airflow.

1. Close all windows, entrance doors, and interior doors (including doors to the furnace enclosure and basement).

2. Turn on the air handler, preferably the fan only, and preferably on High speed.

    - If there is a separate "On-Auto-Off" switch, turn it to On. Turn the "Heat-Off-Cool" switch to Off.
    - If the system must be operating to run the air handler, and it has both Heating and Air Conditioning, choose AC mode.

3. Set up the Manometer to measure Pressure:

    - Connect tubing to the Channel "A" Input tap.
    - Leave the Channel "A" Reference tap *open* (no tubing attached).
    - Turn on the gauge and leave it in the "PR/PR" mode.

4. From the main body of the house, place the tubing under each closed door, including the FAU enclosure and/or basement.

5. Channel "A" now displays the difference in pressure between the closed room and the hallway, created by the air handler pulling against the closed door.

6. For each room, repeat the process, and record the pressure difference between the closed room and the main body of the house.

7. Pressure relief must be provided for any room pressurized or depressurized by **3 Pa or more** with respect to the main body of the house (where the central return is located).

16.11 CORRECTIVE ACTION TO REDUCE IMBALANCE

CORRECT PRESSURE IMBALANCES

Pressure imbalance can be created when a supply register is separated from a central return. Corrective action must be taken for any room pressurized or depressurized by 3 Pa or more with respect to the main body of the house. Some options when the reading is greater than the HDL include the following:

1. Increase Door Undercut. Here are some general guidelines:

    - Undercut shall be up to 2 to 2.5 inches.
    - 1 sq. in. of gap for every 5 sq. ft. of floor area in the closed-off room.

- Before cutting, make sure there will be enough solid wood (bottom rail) left after the cut is made. (If too much rail is cut away, properly-sized solid wood (e.g., from the cut-off) must be pushed up into the hollow door bottom and glued or mechanically secured.)

2. Duct Repair.

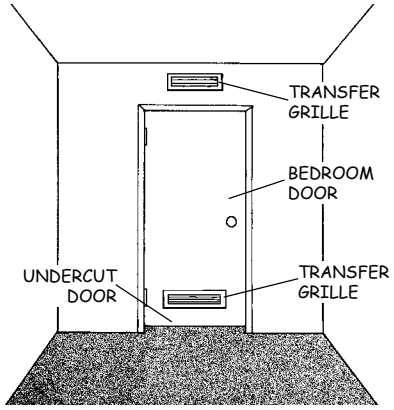
   - Find and seal all accessible duct leaks. For example, return leaks in the CAZ can depressurize the CAZ, and supply leaks to outside can depressurize the living space.

3. Install a Transfer Grille.

   - Non-closeable louvered grille, at least as large as the supply register, installed in the wall or door of the closed room.
   - Additional pressure balancing may be needed in some mobile homes. [14]

4. Install a Jump Duct.

   - Air duct in the attic running from a grille in the ceiling of the closed room to a grille in the hallway ceiling.
   - Return air from the room flows through the duct, into the hallway, and then to the return intake. (Note that jump ducts may not be used for upper CVA venting.)



Graphic Credit: RHA, Inc.

5. Air Handler and Exhaust Fan Changes.

   - It may be feasible to have an HVAC contractor reduce the CFM of the air handler.
   - It is sometimes possible to reduce the capacity (CFM rating) of, or the negative effect of, fans that exhaust air from the CAZ.
   - When a clothes dryer exhausted to outdoors and a natural draft water heater are in a utility room with a closeable door, install a louvered grille of 100 sq. in. NFVA to outdoors (only if the room is unconditioned space) or into the living space (if the utility room is conditioned space)—to reduce depressurization. That is a permanent correction to be utilized when possible.
   - Also, occupants may be advised to open the utility room window slightly when the dryer is operating, if the dryer is causing excessive house depressurization

6. Install a Passive Vent In An Outside Wall to Provide Pressure Relief.

   - See CSD TRM Section 12 (Mechanical Ventilation). This technique should only be used as a last resort and CSD waiver only to resolve depressurization because it brings in unconditioned outdoor air.

[14] When a door or wall separates the living space from a mobile home downdraft FAU with return intake in the FAU housing, an adequately-sized return transfer grille must be present in that door/wall.

Attachments

17. Appliance Default Values

DEFAULT BTUH VALUES

Appliance Type	Default Btuh Input Rating
Forced Air Furnace	• 25,000 Btuh per burner
Wall Furnace	• Single Sided: 35,000 Btuh • Double Sided with two burners: 60,000 Btuh
Floor Furnace	• Standard: 30,000 Btuh (usually 22" wide) • Large: 60,000 Btuh (usually wider than a single floor-joist bay)
Free-Standing (Room) Heater	• Small (up to 25" wide): 25,000 Btuh • Standard (26" to 32" wide): 50,000 Btuh • Large (34" or wider): 60,000Btuh
Gas Fireplace Unit	• 40,000 Btuh
Water Heater	• 1,000 Btuh per gallon
Cooktop Burners and Griddle*	• 10,000 Btuh per burner
Oven*	• 20,000 Btuh per burner
Clothes Dryer*	• 22,000 Btuh

*Note: Clothes dryers shall not be included in calculations for CVA. Cooking appliances shall only be included in calculations of CVA for homes built in 2008 and later.

18. CO Action Levels

- CO "Action Levels" summary below shows the maximum acceptable CO levels in PPM (parts per million). CO PPM *any higher* requires service.
- CO Action Level is the *maximum* CO level that is a "Pass"; any PPM higher is a "Fail.
- Ambient CO is always read "As-Measured". Although flue gas CO readings historically have been "As-Measured", it is more accurate to measure "Air-Free", when the CO tester has an O_2 sensor and can provide "Air-Free" readings.
- CO Action Levels are the same for appliance testing performed (a) before and after weatherization, and (b) after appliances have been serviced/repaired or replaced.

CO Action Levels—Maximum PPM—Before & After Service

Gas Appliance Type	Warm-up Time	Living Space Ambient CO	Appliance Ambient CO	Flue Gas CO "As-Measured"	Flue Gas CO "Air-Free"
SPACE HEATING					
Forced Air Unit (FAU) — Natural Draft, Comb. Air from Living Space	5 minutes	9	**	100	200
FAU— Natural Draft, Comb. Air from Outdoors	5 minutes	9	**	100	400
FAU—Induced Draft	5 minutes	9	**	100	200
FAU—Direct Vent	5 minutes	9	**	100	400
Gravity Ducted Furnace	5 minutes	9	**	100	400
Wall Furnace & Room Heater— Natural Draft	5 minutes	9	**	50	200
Wall Furnace—Direct Vent	5 minutes	9	**	100	400
Floor Furnace	5 minutes	9	**	100	400

Gas Appliance Type	Warm-up Time	Living Space Ambient CO	Appliance Ambient CO	Flue Gas CO "As-Measured"	Flue Gas CO "Air-Free"
WATER HEATERS—Storage					
Natural Draft, Comb. Air from Living Space	5 minutes	n/a	9	50	200
Natural Draft, All Others	5 minutes	n/a	9	100	400
Induced Draft	5 minutes	n/a	9	100	400
Direct Vent	5 minutes	n/a	9	100	400
COOKING†					
Cooktop Burners	15 sec. to 4 min	n/a	n/a	100	n/a
Griddle	5 min. to 10 min.	n/a	n/a	100	n/a
Oven & Broiler	10 min. to 30 min.	n/a	n/a	200	n/a
Range Heater/Incinerator	5 min. to 10 min.	9	**	n/a	n/a
FIREPLACE†					
Gas Log	10 min. to 20 min	n/a	n/a	40	n/a
Gas Fireplace Unit—Natural Draft	5 minutes	9	**	100	400
Gas Fireplace Unit—Direct Vent	5 minutes	9	**	100	400
CLOTHES DRYER					
Gas Dryer	30 seconds	n/a	n/a	100	n/a

† For Warm-up: If CO is too high after minimum warm-up time (first number), continue operating up to the maximum warm-up time (second number).

**2 ppm above 2nd Living Space Ambient CO is the maximum for all space heating appliances.

19. CAS Tests Required, By Appliance Type

Appliance Type	Gas Leak Check	Visual Inspection	CVA Evaluation	Living Space Ambient CO	Appliance Ambient CO	Flue Gas CO	Draft Test	Spillage Check	CAZ Test
NATURAL DRAFT	**SPACE HEATING—GAS**								
Forced Air Unit (FAU)	X	X	X	X	X	X	X	X	X[1]
Wall Furnace	X	X	X	X	X	X	X	X	X[1]
Floor Furnace	X	X	X	X	X	X	X	X	
Freestanding (Room) Heater	X	X	X	X	X	X	X	X	X[1]
INDUCED DRAFT									
Forced Air Unit (FAU)	X	X	X	X	X	X	X[2]		X[1]
CLOSED COMBUSTION (DIRECT VENT)									
Forced Air Unit (FAU)	X	X		X	X	X			
Wall Furnace	X	X		X	X	X			
NATURAL DRAFT—INDOORS	**WATER HEATING—GAS**								
Storage Water Heater	X	X	X			X	X	X	X[1]
Tankless Water Heater	X	X	X			X	X	X	
NATURAL DRAFT—OUTDOORS—WITH ADEQUATE CLEARANCE FROM DOOR AND OPENABLE WINDOW[5]									
Storage Water Heater	X	X							
Tankless Water Heater	X	X							
INDUCED DRAFT									
Storage Water Heater	X	X	X		X[4]	X	X[2]		
CLOSED COMBUSTION (DIRECT VENT)—INDOORS & OUTDOORS									
Storage Water Heater	X	X			X[4]	X			
Tankless Water Heater	X	X			X[4]	X			

(See footnotes on next page)

GAS LOG	FIREPLACE & SOLID FUEL								
Primary Heat	X	X				X	X[6]		X[1]
Not Primary Heat	X	X				X	X		X[1]
GAS FIREPLACE & INSERT									
Open Combustion	X	X		X	X	X	X		X[1]
Direct Vent	X	X				X			
SOLID FUEL SPACE HEATER—WOOD OR PELLET									
Stove or Fireplace Insert		X							X[1,3]
COOKING APPLIANCES—GAS	**COOKING & DRYER**								
Cooktop Burner & Griddle	X	X	X[7]			X			
Oven/Broiler	X	X	X[7]			X	X[8]		
Convection Oven	X	X	X[7]			X	X[8]		
Heater/Incinerator	X	X	X[7]			X	X[8]		
CLOTHES DRYER—GAS									
Inside/Outside Living Space	X	X				X			

[1] In a mobile home, CAZ testing is required if appliance draws air from the living space.
[2] Draft test is required only when a hole to measure CO is drilled in the vent pipe.
[3] In a conventional home, CAZ testing is required if appliance draws air from the living space.
[4] When flue gas CO cannot be measured, CO measurement is limited to appliance ambient CO testing only.
[5] More than 4' below or to the side of, or 1' above, an operable door or window into the living space.
[6] Fireplace damper must be permanently blocked partially open enough to create proper draft of combustion gases up the chimney.
[7] For homes built in 2008 or later, the gas cooking appliance must be included in CVA evaluations.
[8] Draft test is performed when possible on cooking appliances that have a draft hood and vent pipe to outdoors.

19.1 CO TEST LOCATIONS

FURNACES

CO MEASURED SEPARATELY
IN EACH EXHAUST PORT (FLUE)

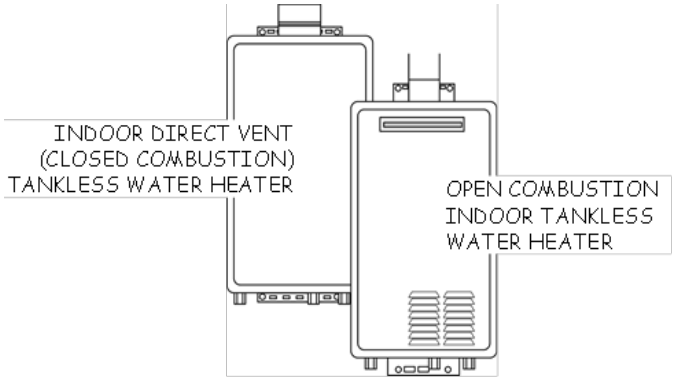
Graphic Credit for All Graphics on This Page:
RHA, Inc.

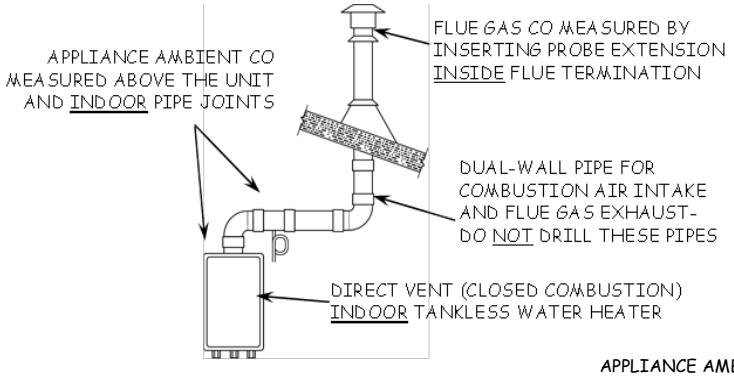
STORAGE WATER HEATERS

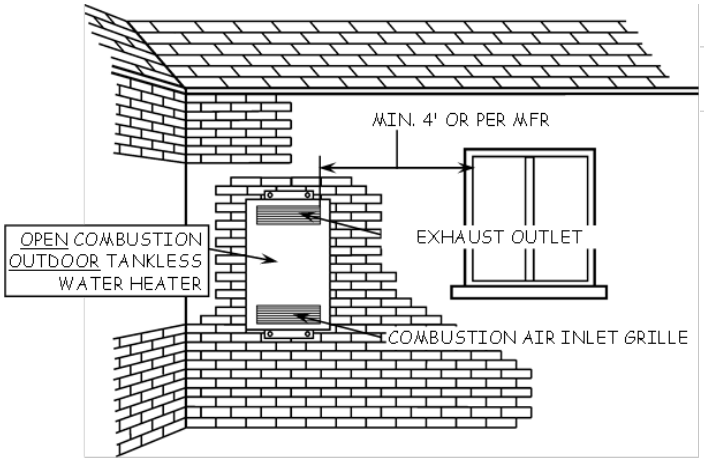
TEST PROBE/EXTENSION IS PLACED INSIDE THE
CENTER TUBE ON EACH SIDE OF THE BAFFLE

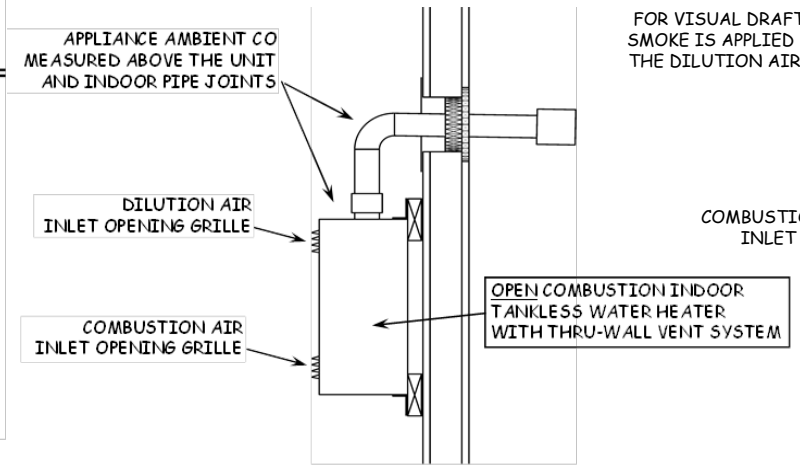
19.1 CO TEST LOCATIONS (cont.)

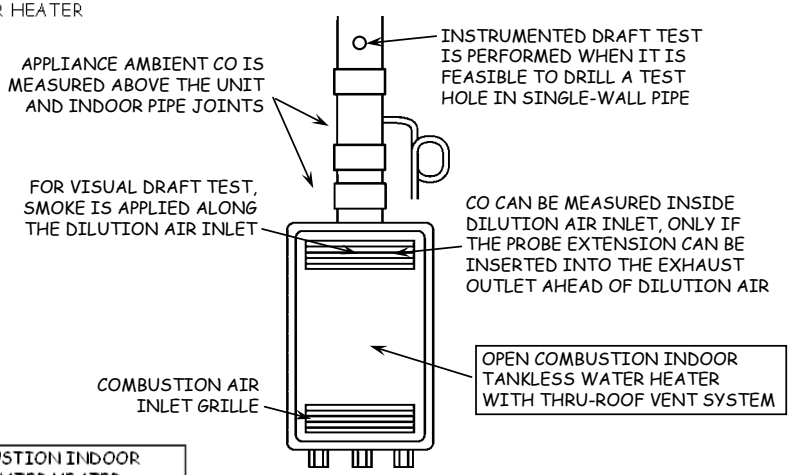
TANKLESS WATER HEATERS







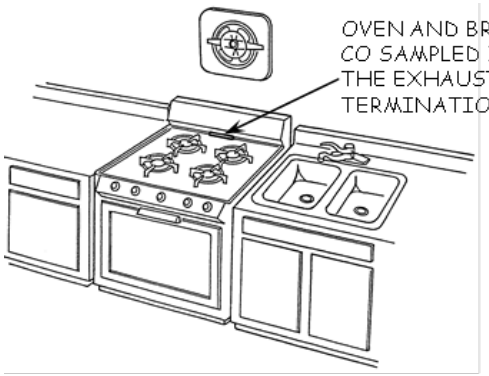


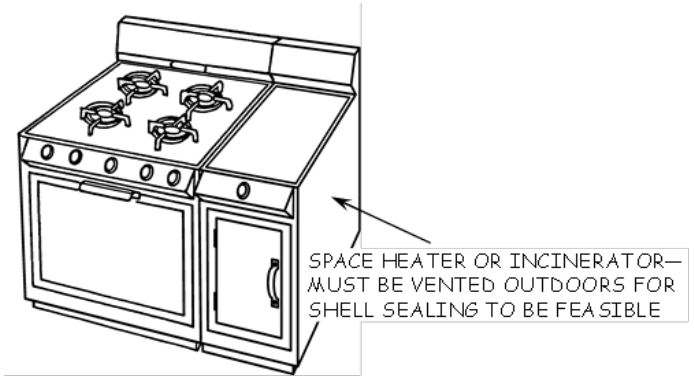


Graphic Credit for All Graphics on This Page: RHA, Inc.

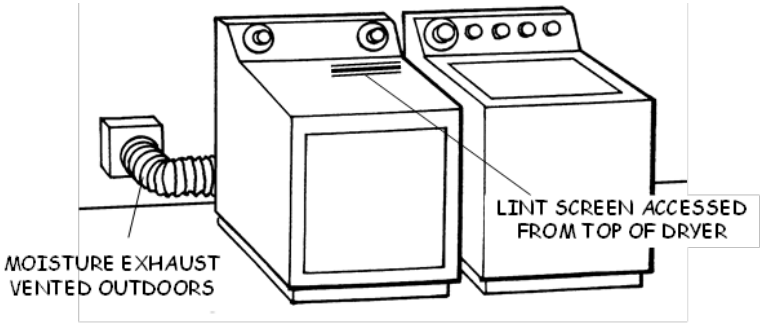
19.1 CO TEST LOCATIONS (cont.):

COOKING SYSTEMS

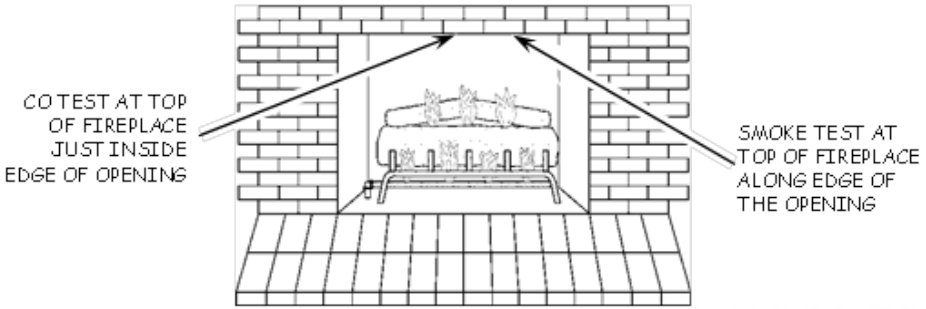




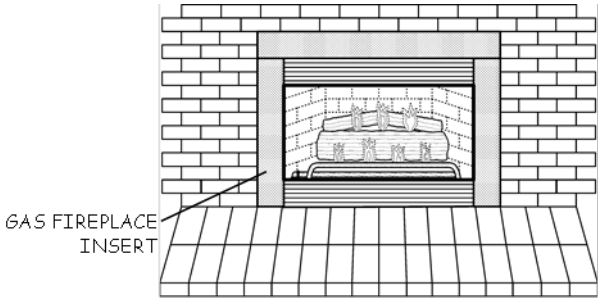
CLOTHES DRYERS



GAS LOGS



GAS FIREPLACES AND INSERTS



Graphic Credit for All Graphics on This Page:
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20. Special Policies for Gas Refrigerators

Graphic Credit: DYNAMX, Inc, www.warehouseappliance.com.

20.1 VISUAL INSPECTION

When a gas-fueled refrigerator is present in a home, the following protocol applies:

- Standard gas leak procedures shall be followed to check for and repair gas leaks.
- If the appliance is *not* vented outdoors, manufacturer's instructions shall be researched to determine if an exhaust vent to outdoors is specified.
- Infiltration-reduction measures shall not be installed when manufacturer's instructions:
  - Cannot be found, or
  - Specify installation of exhaust vent to outdoors, but vent is not present.

20.2 REQUIRED TESTING PROCEDURES

- Appliance ambient CO shall be measured just above the top and to each side of the Refrigerator (measured near the openings, when the appliance is recessed into an alcove).
- Infiltration-reduction measures shall not be installed when Appliance Ambient CO is 10 PPM or higher.
- A CO Alarm shall be located within 15' of the gas Refrigerator, but at least 5' (or manufacturer's recommendation) away from kitchen cooking and exhaust appliances.

Appendix B: Duct Leakage Test Protocol

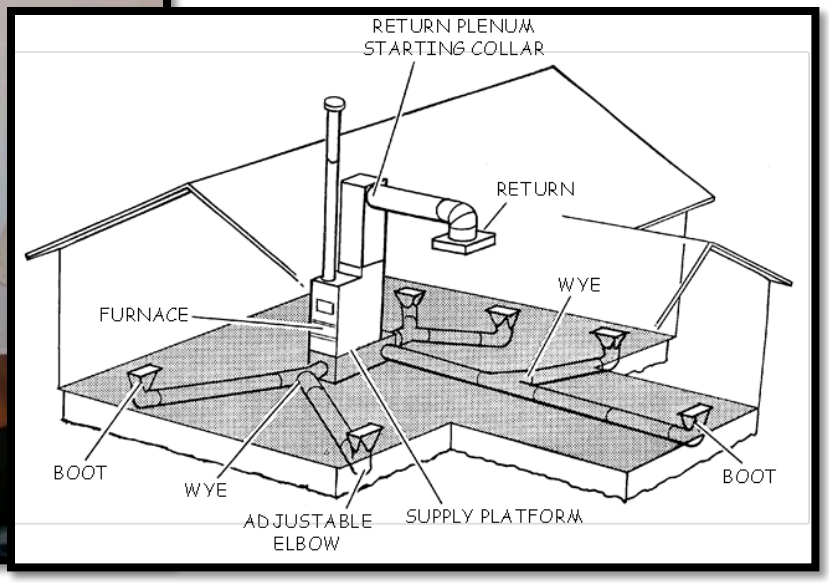

Photo Credit: CAP San Luis Obispo

Graphic Credit: RHA, Inc.

DEPARTMENT OF COMMUNITY SERVICES AND DEVELOPMENT

Effective 7/1/2023

Table of Contents

Preface

2022 Title 24 and CSD duct leakage requirements are divided into four categories. When:

1. **Less than 25' of new or replacement ducts are installed, no heating, ventilation, and air conditioning (HVAC) alteration[1] is completed, and only duct sealing work is required**: The Duct Leakage Targets will be as described in TRM Appendix B, Table 5.5.2 as "Duct Leakage Testing Formulas…When a HERS Rater Verification is Not Required".
2. **When the entire duct system is less than 40' in total**: 2022 Title 24 Duct Leakage Targets identified in TRM Appendix B Table 5.5.2 will not apply.

In compliance with California's Title 24, when items 3 or 4 below are performed in a single-family or multi-family home, confirmation of achieving the Duct Leakage Target must be verified by a certified HERS Rater. When:

3. **25' or more of new or replacement ducts are installed or an HVAC alteration[1] to one or more heating/cooling system components will be made:** 2022 Title 24 Duct Leakage Targets as defined below will apply, and HERS Rater verification is required:

Duct Sealing Targets	Single-Family*	Multi-Family**
Total Leakage Test	**10%** *(Start: 11%)*	**15%** *(Start: 16%)*
Leakage to Outside Test	**7%** *(Start: 8%)*	**10%** *(Start: 11%)*
* Not applicable to Mobile Homes. ** Per 2022 California Building Code for occupancy groups relative to CSD's weatherization programs, multi-family buildings are defined as having two or more units.		

4. **Garage Location:** When new or replacement HVAC ducts are installed of any length in a garage, or air-handling units, cooling or heating coils, or plenums *are located in a garage in a single-family dwelling will be altered*[1], the 2022 Title 24 Duct Leakage Target for single-family is ≤6% total duct leakage. HERS Rater verification is required.

If it is not possible to meet the Duct Leakage Targets defined in Table 5.5.2, then all accessible leaks shall be sealed and verified through a visual inspection and a smoke test. This method of sealing all accessible leaks will be confirmed by a certified HERS Rater when HERS verification is required.

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[1] HVAC alterations include, but are not limited to, replacement of an air handler, outdoor condensing unit of a split system air conditioner or heat pump, the cooling or heating coil, etc.).

1. Duct Leakage Test Diagnostic

1.1 WHAT IS DUCT LEAKAGE TESTING?

Duct leakage testing uses visual inspection and pressure testing methods to locate and correct air leaks in a duct system. The final goal of the duct testing and sealing work is for the duct system to be energy efficient, balanced, and provide even air movement throughout the living space when room doors are closed.

1.2 CSD DUCT LEAKAGE TESTING AND SEALING POLICY

CSD requires that all homes with duct systems be tested and sealed, when feasible. The order of all duct sealing work (with or without testing) shall follow the CSD 706 form that lists all duct leakage activities in prioritization order, without exception.

All material selection, surface preparation, and material installation shall comply with the CSD Technical Reference Manual (TRM), all manufacturer's instructions, and local codes, with the most stringent requirement(s) taking precedence.

1.3 ORDER OF PERFORMANCE

When feasible, duct testing/sealing also shall be completed before shell leakage testing and shell sealing occurs.

1.4 FEASIBILITY CRITERIA

Duct **testing** shall be performed when:

1. The duct system is made of:
    a. Rigid metal, flexible metal, flexible plastic, and rigid and flexible fiberglass, or
    b. Construction materials (e.g., wood, gypsum, and sheet metal) used in platform returns/structural cavities serving as ducts.
2. At least 40 feet of duct work is present in unconditioned space (Note: If < 40 feet of duct work is present, testing is not feasible, but sealing is allowed when duct materials conform with CSD policy).
3. Infiltration reduction measures are feasible (home is not NIM).
4. The ducts and FAU are accessible.
5. Ducts and existing disconnections are accessible.

Note: When the FAU shares ducts with an evaporative cooler, the ductwork must be isolated from the cooler by a functional damper (or a damper shall be added) for the Duct Leakage Test to be feasible.

Duct **testing** shall NOT be performed when:

1. Unfeasible in the CSD Technical Reference Manual (TRM) measure-specific feasibility criteria.
2. One or more registers cannot be blocked in compliance with this protocol.
3. The duct system is excessively damaged or deteriorated.
4. The entire duct system is inside the thermal envelope (living space).
5. Duct sealing is not feasible because:
    a. The dwelling is NIM.
    b. Ducts are in the attic or crawlspace and crawl area clearance is inadequate, or
    c. A CAS hazard or indoor air quality (IAQ) fail exists that cannot be corrected.
    d. An unsafe condition is present, or
    e. Evidence of rodent or pest infestation is present inside the duct interior.
6. Duct testing or duct sealing would violate CSD Health and Safety Requirements (CSD TRM Appendix E).
7. Client refuses—after diagnostic benefits have been explained.

8. **[Mobile Home]** Duct sealing is not feasible because:
    a. In accordance with HUD code for mobile homes, an open combustion gas-burning space heater or water heater is present that draws combustion air from the living space. Home is NIM.
    b. It is unfeasible to abandon the belly return to install a central ducted return (Note: makes sealing of return-side unfeasible only. Supply-side sealing may still be accomplished).
9. **[Mobile Home]** An open combustion solid-fuel burning space heater (i.e., fireplace, insert, wood stove) is drawing combustion air from the living space. Home is NIM and sealing is not feasible. CSD Exception: Pressure diagnostics and infiltration-reduction measures shall be allowed when:
    a. Pressure measurement shows the CAZ of each appliance is less negative than the HDL (see procedures described in CSD TRM Appendix A); and
    b. Installed measures do not depressurize the CAZ beyond the HDL.

1.5 CLIENT REFUSAL

If a client refuses duct leakage testing:

- The refusal shall be documented in the CSD 542 Deferral Form by the Assessor, with client signature and date.
- **(DOE Program)** A full home deferral is required when DOE funds are used.
- **(LIHEAP)** A *limited deferral* is required. Duct sealing of catastrophic leakage only shall be performed. Note: Duct leaks shall NOT be sealed when a CAS or IAQ fail exists that cannot be corrected within the scope of the weatherization program.

1.6 REQUIRED DEFERRAL

When CAS or IAQ fails cannot be corrected, one of the following consequences shall result:

- **(DOE Program)** When DOE funds are used, the dwelling shall be fully deferred.

- **(LIHEAP)** Limited deferral is required, and only non-infiltration reduction measures shall be installed; however, careful evaluation shall be performed to determine if non-sealing measures are achievable, reasonable, cost-effective, and it is safe for workers to enter the home.

1.7 ASBESTOS

When any part of a duct system is known, or suspected to be *made of or insulated with* asbestos containing materials (ACM), no action shall be taken which will cause such material to be un-encapsulated or discharged into the air. Feasibility of duct testing and sealing work is determined by the CSD Asbestos Policy, located in CSD TRM Appendix E.

2. Duct Testing Equipment and Calibration Requirements

Duct leakage diagnostic equipment shall be utilized in accordance with CSD's and manufacturer's recommendations for equipment set-up, operation, maintenance, and calibration.

- "Total Duct Leakage" shall be measured using an approved duct tester (e.g., Duct Blaster®). The Blower Door "subtraction method" shall not be used.
- "Leakage to Outside" shall be measured using a duct tester, in combination with a Blower Door, when building cavities are used as ducts, or most ducting is inside the thermal envelope. Follow equipment manufacturer's instructions for proper protocol.

2.1 STANDARD EQUIPMENT MINIMUM SPECIFICATIONS

CSD requires that all equipment be purchased and maintained in accordance with the specifications below. Equipment that does not meet these requirements shall be considered an inspection fail during the inspection process.

2.1.1 Equipment

- Pressure Measurements
  - Measurement systems shall have an accuracy of ± 0.2 Pa or 1% of reading, whichever is greater, and
  - Static pressure probes specified by the measurement equipment manufacturer shall be used.
- Duct Leakage Measurements
  - Duct leakage testing shall have an accuracy of ± 3% of measured flow, and
  - Shall utilize digital gauges specified by the measurement equipment manufacturer.

Photo Credit: WAPTAC.org

- Test Equipment
  - Equipment used to measure duct leakage may include, but is not limited to, a Minneapolis Duct Blaster® or Retrotec Duc-Tester®.
  - Smoke (e.g., from an incense stick, smoke pencil, smoke puffer, etc.) with tactile tests, gauge readings, etc. shall be used as appropriate to determine leak sources.

2.1.2 Calibration of Equipment

Test equipment shall be maintained properly and calibrated regularly *in accordance with manufacturer's recommendations*. Records of all calibrations and equipment checks shall be kept in an equipment calibration log, as specified by CSD. Digital gauges shall be calibrated annually, by the factory, or by using field calibration procedures.

3. Duct Leakage Test Types and Triggers

CSD requires that assessors/crews perform:

- Initial Duct Leakage Tests
  - Test determines if duct sealing is feasible by the amount of initial duct leakage.
- Incremental Tests
  - During duct sealing work, "Incremental" tests shall be performed after performing each sealing increment to determine whether continued sealing work is feasible or if sealing work shall stop.
- Post-Weatherization Duct Leakage Tests
  - After completion of all feasible duct sealing, post-test shall determine the:
    - Final duct leakage amount;
    - Leakage reduction achieved; and
    - Percentage of total reduction.

4. Recordkeeping

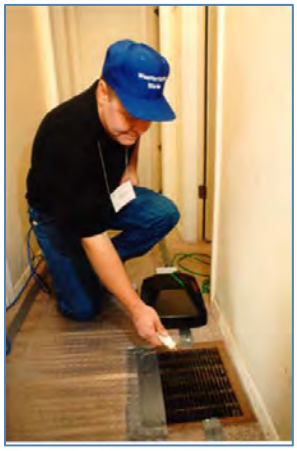


Photo Credit: WAPTAC.org

The Assessor's visual inspection notes and feasibility/unfeasibility for each of the Priority 1-3 sealing work activities shall be documented on the CSD 706 form.

Installers shall document incremental sealing work and test results performed by the crews for each of the Priority 1-3 sealing work activities identified by Assessor on the CSD Duct Leakage Data Sheet (CSD 706 form). All HERS and permit documentation shall also be collected (see callout box on the following page).

- To pass the post-inspection, all required documentation from the Assessor and Installers must be completed, required testing must be performed, and the Duct Leakage Data Sheet must be completely and accurately filled out. Results from the Inspector and inspector re-testing data (when required) shall be logged on the CSD 611.
- The CSD 706 form is required to be stored in the client's permanent file, and must be accurate, legible, and properly filled out.
- Copies of the most current forms may be found on CSD's Providers' website.

HERS (Home Energy Rating System) Requirements

Most frequently, agencies will perform duct sealing to verify that clients' ducts have been sealed to the lowest practical level under the CSD TRM guidance. However, in any conventional home where an HVAC repair or replacement occurs *that requires a building permit*, duct sealing requirements also are set by Title 24 regulations.

When you, or a subcontractor, pull a permit, you must work with a licensed HVAC contractor to determine the code requirements that will apply. HVAC system "alterations" that will likely require a permit are:

- Installation of a completely new HVAC system.
- Replacement of a package unit.
- Replacement of an air handler.
- Replacement of a condenser unit.
- Replacement of an evaporator coil.
- Replacement of a heating coil.
- Replacement of a furnace heat exchanger.
- Adding or replacing more than 25-feet of ducts in unconditioned space.

When the duct system is required to be tested and certified by HERS Rater, a copy of the "finaled" building permit and the HERS Rater report that shows HERS rater's final CFM_{25} and score of "pass" shall be kept in client file.

5. Duct Assessment Procedure

In accordance with CSD policy, all duct systems in a dwelling shall be tested, and ducts shall be sealed as feasible, even if the connected FAU is not the primary heating/cooling source. Total duct leakage is measured and recorded in CFM25.

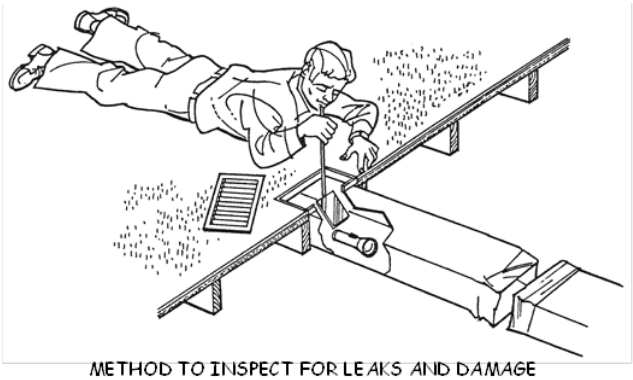
5.1 VISUAL ASSESSMENT

Visual assessment of a duct system shall be performed by the Assessor to determine the initial condition of the system, decide if testing is feasible, and to prescribe the sealing activities. The following are many areas that the Assessors shall check, by housing type. As leaks are found, they shall be documented in the CSD 706 form.

5.1.1 Duct System Visual Inspection—Conventional Homes

- Check plenum/cabinet connections and start collar attachments for leaks.
- Inspect platform returns for gaps around framing and open wall cavities.
- Check for leaks in all accessible building cavities used as ducts.

- Shake rigid ducts to find loose connections and look for discolored fiberglass insulation (dark stains) and other evidence of leaks.
- Check flex ducts for tears, check flex connections for leaks (especially those with old, dry loose tape), and look for crushed metal flex.
- Check all wyes, elbows and boot connections for leakage (Note: It is not necessary to remove insulation when there is no visual evidence of leakage).
- Check for closed in-line dampers.
- Look for improperly altered components which leak (e.g., seam separation on the end of a rigid pipe used to make an improvised "increaser").



METHOD TO INSPECT FOR LEAKS AND DAMAGE
Graphic Credit: RHA, Inc.

- Check ducts lying in dirt or subject to damage by moisture, animals, or humans.
- Check for broken or missing duct supports.
- Remove return grilles and a representative sample of supply registers to check gap size and other potential leaks.

5.1.2 Duct System Visual Inspection—Mobile Homes

- Remove registers and grilles and inspect all ducts with a mirror and strong light. Look for gaps around the boot, and defects in the ducts (separations, crushed walls, leaky ends, etc.).
- When furnace has an open return (not ducted into the plenum), check the furnace enclosure for gaps that can leak outside air into the return flow. These typically include gaps where the flue penetrates the ceiling and holes where pipes and other hardware penetrate the floor.
- When the furnace is accessed from outdoors, and the enclosure is the return plenum, check for leaks into the return system. When there is an adjacent water heater, check for breaches in the dividing partition and anywhere else that could allow water heater combustion gases to be drawn into the return flow.
- When duct defects cannot be reached from indoors, they are accessed through the belly. The belly board shall be cut neatly, replaced, and repaired as prescribed in the CSD TRM.
- Inspect belly return and attic return systems.

5.2 WHEN DUCT TESTING IS *NOT* FEASIBLE

When duct testing is not feasible—see Feasibility Criteria in this Appendix—duct sealing may still be performed in accordance with the CSD 706 form, unless expressly prohibited (i.e., home is NIM, due to disturbing hazardous material like ACM, or by making an existing health and safety condition worse). In cases where sealing is feasible but testing is not (i.e., if one or more registers is inaccessible):

- The condition that causes testing to be unfeasible shall be fully described in the "Reason Testing is Not Feasible" line on the CSD 706. Locations that commonly have leaks are identified in order of priority on the CSD 706 form and still shall be sealed in that order.
- For homes that were selected for evaluation by a HERS rater (as a condition of a building permit) but duct testing was not feasible, sealing activities shall be verified with a smoke test. 100% of these jobs are subject to inspection and certification by a HERS Rater. The HERS rater also shall be provided with a complete description of what sealing activities were done on the appropriate HERS documentation.
- Note: HERS duct testing/sealing requirements do not apply to:
  - Systems with 40 or fewer linear feet of ducts in unconditioned space, and
  - Systems constructed, insulated, or sealed with asbestos.

5.3 WHEN DUCT TESTING *IS* FEASIBLE

When duct testing is feasible, the procedures outlined in the following Sections 5.4 to 5.8 shall be followed and documented on the CSD 706 form.

The procedure to test the ducts requires only **5** basic steps:

1. Decide if you will perform a "Total Leakage" test or a "Leakage to Outside" test.
2. Use system airflow to calculate START and TARGET/STOP CFM25 leakage values.
3. Set up the home for testing.
4. Follow the CSD 706 Duct Leakage Test Procedure.
5. Balance the duct system.

5.4 STEP 1: DETERMINE THE TEST TYPE

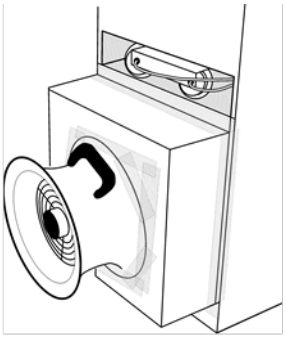
Currently approved test procedures in California's Title 24 are described below:

5.4.1 Total Leakage

When conducting a Total Leakage test, connect the duct tester to a central return or air handler and measure the air flow (cubic feet per minute or CFM) needed to pressurize the ducts to 25 Pascals (Pa). This test measures all existing duct leakage. ***For weatherization workers, this test is the most common.***

5.4.2 Leakage to Outside

When homes contain a return path or building cavity located entirely inside the home (e.g., a "chase return" in a two-story dwelling), field personnel may use this testing procedure, known as the Leakage to Outside test. This test procedure is intended to measure only those duct leaks to outside the building envelope, such as attics/crawlspaces, garages, or other unconditioned areas, and excludes leaks that are within the building envelope.



Graphic Credit: RHA, Inc.

The Leakage to Outside test is not applicable to dwelling units with platform returns or units where the return intake is located directly at the FAU.

The Leakage to Outside test requires you to:

- Pressurize the house with a Blower Door to 25 Pa.
- Pressurize the ducts to 25 Pa by connecting duct tester to the central return or air handler.
- CFM flowing through the duct tester is the amount of leakage to outside.
- Document the results in accordance with the 2016 Title 24 requirements in the 2016 Reference Appendices (RA2.8 and RA3.1.4.3.4).

5.4.3 Testing Supply Side Only

When it is feasible to test only the supply side of the duct system (such as when a belly return cannot be abandoned and replaced with a central ducted return for a mobile home), a special procedure is used, as described below:

- The duct tester is connected directly to the FAU, per manufacturer's instructions.
- Isolate and block off the return from the supply side (e.g., with cardboard and tape), so only supply side duct leakage is measured.

5.5 STEP 2: CALCULATE START AND TARGET/STOP IN CFM25

Assessors shall identify system airflow in accordance with the current Title 24 Residential ACM Manual, Appendix RC, and use the practices and worksheet identified in this section.

5.5.1 Identifying Airflow

Because system airflow is not always listed on the appliance nameplate (manufacturer label), there are several methods for calculating the airflow. The worksheet and calculation guide on the following pages provide steps for each method.

5.5.2 Calculating Start and Target/Stop

Duct sealing "start" and "stop" calculations are summarized in Table 5.5.2.

TABLE: 5.5.2: DUCT LEAKAGE TESTING FORMULAS

When a HERS Rater Verification Is Required – SINGLE-FAMILY[1,2,3,4]		
	Total Leakage Test	**Leakage to Outside Test**
START CFM25	**≥11%:** (system airflow) x (0.11)	**≥8%:** (system airflow) x (0.08)
TARGET/STOP CFM25	**<10%:** (system airflow) x (0.10) OR LOWER	**<8%:** (system airflow) x (0.07) OR LOWER
When a HERS Rater Verification Is Required – MULTI-FAMILY[1,2,3,5]		
	Total Leakage Test	**Leakage to Outside Test**
START CFM25	**≥16%:** (system airflow) x (0.16)	**≥11%:** (system airflow) x (0.11)
TARGET/STOP CFM25	**<15%:** (system airflow) x (0.15) OR LOWER	**<10%:** (system airflow) x (0.10) OR LOWER
When a HERS Rater Verification is Not Required[1,2,3,4]		
	Total Leakage Test	**Leakage to Outside Test**
START CFM25	**≥16%:** (system airflow) x (0.16)	**≥11%:** (system airflow) x (0.11)
TARGET/STOP CFM25	**<15%:** (system airflow) x (0.15) OR LOWER	**<10%:** (system airflow) x (0.10) OR LOWER

[1] If Total Leakage cannot be brought to, or below, below the duct leakage target, all accessible duct leaks shall be sealed and confirmed with a smoke test.

[2] As long as leakage is above the Target/Stop CFM25 and accessible duct sealing opportunities still remain, sealing *shall* continue.

[3] When 75% or more of a duct system is replaced, Title 24 requires that the duct system be reduced to ≤ 5% total leakage and the formulas above no longer apply.

[4] HERS Rater verification does not apply to Mobile Homes.

[5] Per 2022 California Building Code for occupancy groups relative to CSD's weatherization programs, multi-family buildings are defined as having two or more units.

Contractors shall certify duct leakage to be an acceptable percentage of fan flow (see Table 5.5.2 above), with a sampling of jobs subject to inspection and verification by a HERS Rater.

When the duct system will be inspected and verified by a HERS rater, and target cannot be reached, all accessible leaks are sealed and verified with a smoke test. Accessibility and limits of accessibility for HERS raters are defined in the Title 24 Residential Compliance Manual, Section 9.6 “Alterations, under “HVAC Changeouts,” item B “Accessible Ducts.”

5.5.3 Airflow and Start/Stop Calculation Worksheet

See next page.

1. Obtain System Information from the Heating and/or Cooling Unit Manufacturer Label(s)

(1a)	**AC Condenser** (Heating & AC or AC-Only)		
	Mfr:	Model:	**AC Tons:**
(1b)	Floor Area Default—Conditioned Space: _____ sq. ft.		**AC Tons:**

(2a)	**Gas Furnace** (Heating Only)		
	Mfr:	Model:	**kBtuh Output:**
(2b)	Floor Area Default[6]—Conditioned Space: _____ sq. ft.		**kBtuh Output:**

(3)	**Electric Furnace** (Heating Only)	From Nameplate/Label→	**CFM:**
	Mfr:	Model:	**Output:**

2. Determine System Capacity in Order to Estimate System Airflow

- For AC-only systems, calculate AC Tons. For Heat-only systems, calculate Btuh.
- If the HVAC system is a combination heating and air conditioning unit, estimate airflow for both heating and AC, and use the higher CFM value of the two.

SYSTEM	**CAPACITY** (UNITS)	**CFM** PER UNIT	**AIRFLOW CFM** (units) x (CFM/unit)	**FOR COMBINATION HEATING & COOLING, SELECT THE APPLIANCE WITH HIGHEST CFM**
Air Conditioner [A]	Tons	400	CFM	☐
Gas Furnace [B]	kBtuh	21.7	CFM	☐
Electric Furnace [C]			CFM	☐

3. Identify the Test Type to be conducted. Complete the calculations for the appropriate Table below.

Leakage to Outside[4]—Airflow and Start/Stop Calculations

SYSTEM (CIRCLE ONE)	**AIRFLOW CFM**	**START CFM** (airflow) x (__Percent)	**TARGET/STOP CFM**[3] (airflow) x (__Percent)
[A] [B] [C]	CFM	CFM_{25}	CFM_{25}

[3] Note: As long as leakage is above the Target/Stop CFM25 and accessible duct sealing opportunities still remain, sealing *shall* continue.

[4] This table for convenience only. Title 24 procedures and CED Residential Compliance Forms shall be used and applied.

Total Duct Leakage—Airflow and Start/Stop Calculations

SYSTEM (CIRCLE ONE)	**AIRFLOW CFM**	**START CFM** (airflow) x (__Percent)	**STOP CFM**[5] (airflow) x (__Percent)
[A] [B] [C]	CFM	CFM_{25}	CFM_{25}

[5] Note: As long as leakage is above the Target/Stop CFM25 and accessible duct sealing opportunities still remain, sealing *shall* continue.

GUIDE TO ESTIMATE SYSTEM AIRFLOW

ESTIMATING AIRFLOW—AIR CONDITIONERS OR HEAT PUMPS

There are generally two methods to determine airflow:
1) By interpreting data from the appliance nameplate (Method A or Method B); or
2) If the nameplate is not available, by performing an alternate calculation (Method C).

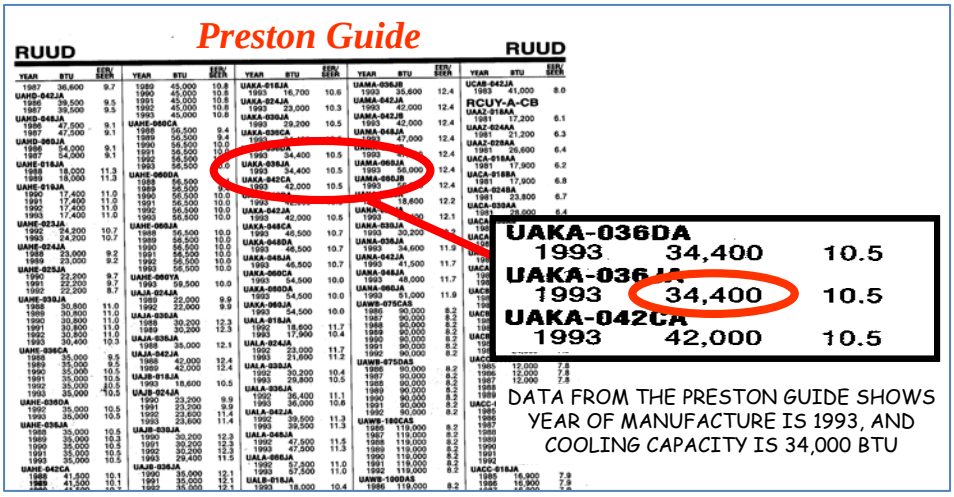
AC/HP METHOD A—LOOK-UP VALUE IN PRESTON GUIDE OR CARRIER BLUEBOOK

Step A-1: Determine the model number and date of manufacture from the condenser nameplate. Use data to look up the cooling capacity of the unit in the Preston Guide or Carrier Bluebook.

NAMEPLATE SHOWS MODEL NUMBER TO BE "UAKA-036JAS"	NAMEPLATE SHOWS DATE OF MANUFACTURE TO BE "09/93"

Step A-2: In the sample Preston Guide page below, find:

a. Model number = UAKA-036JA
b. Year manufactured = 1993
c. Cooling capacity = 34,400 Btu (34.4 kBtuh)



Step A-3: Determine AC Tons (based on Btu) by calculating BTU ÷ 12,000 = AC Tons.

$$\frac{\textbf{Btu}\ (\text{Unit Capacity})}{\textbf{12,000}\ (\text{Btu/Ton})} = \frac{34{,}400\ \text{Btu}}{12{,}000\ (\text{Btu/Ton})} = 2.87\ \text{AC Tons}$$ (Round up to 3 tons)

Use the result from Method A to fill in the "Capacity (Units)" box on the **"5.5.3 AIRFLOW AND START/STOP CALCULATION WORKSHEET."**

AC/HP METHOD B—MODEL NUMBER CLASSIFICATION

You can also determine the AC Tons directly from the model number:

Step B-1: Locate model number on condenser nameplate.

a. ***Example: Using the nameplate pictured above, the model number is "UAKA-036JAS."***

b. **For kBtuh, look for a 3-digit number beginning with zero (i.e., "036").**

c. **36 indicates unit capacity in kBtuh, which is 36 kBtuh, or 36,000 Btuh.**

Step B-2: Determine AC Tons (based on Btu) by calculating BTU ÷ 12,000 = _____AC Tons.

Example: 36,000 Btuh ÷ 12,000 = 3 AC Tons

Use the result from Method B to fill in the "Capacity (Units)" box on the **"5.5.3 AIRFLOW AND START/STOP CALCULATION WORKSHEET."**

AC/HP METHOD C—FLOOR AREA DEFAULT

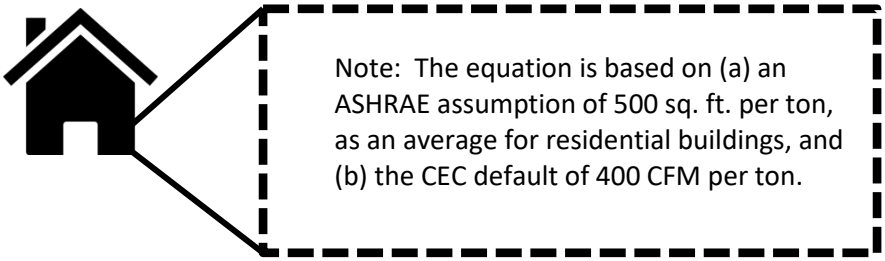
When the **AC** nameplate is inaccessible or unreadable/missing and it is a CSD duct sealing job only (It is not required to be a Title 24 job), use the Floor Area Default equation below:

Step C-1: Measure and calculate sq. ft. of the conditioned space.

Step C-2: Calculate: **Floor Area (sq. ft.) x 0.8 = Airflow CFM**

Use the result from Method C to fill in the "Airflow (units) x (CFM/unit)" box on the **"5.5.2 AIRFLOW AND START/STOP CALCULATION WORKSHEET."**

Example: 1,500 sq. ft. house x 0.8 = 1,200 CFM System Airflow



ESTIMATING AIRFLOW—GAS FURNACES

For gas furnaces, there are two methods to estimate the airflow. Remember: When the HVAC unit is a package unit (combination heating and air conditioner), you must estimate CFM for both heating and cooling, but will only use the higher CFM to calculate your Start and Stop readings. Use the result from both of these Methods (A and B) to fill in the "Airflow (units) x (CFM/unit)" box on the **"5.5.3 AIRFLOW AND START/STOP CALCULATION WORKSHEET."**

GAS FURNACE METHOD A—BTUH OUTPUT

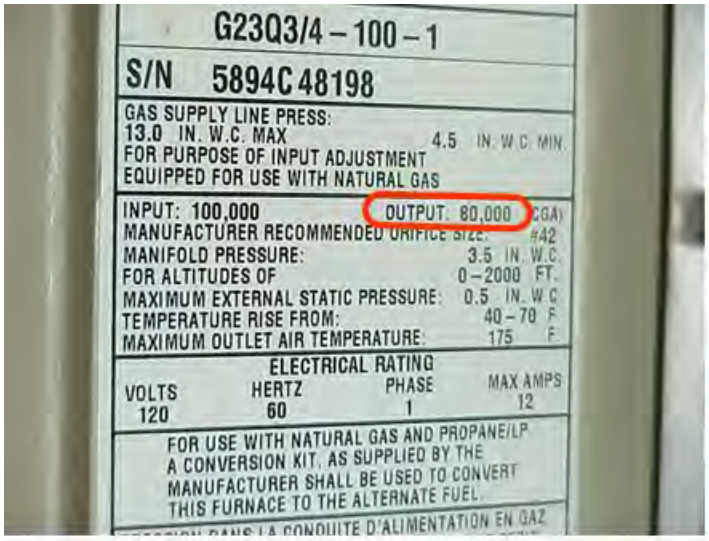
Step A-1: When a nameplate is available, locate Btuh Output on the label.

Step A-2: Convert Btuh Output to Estimated Airflow in CFM, using this equation:

(kBtuh Output**) x (21.7** CFM/kBtuh**) =** Airflow in **CFM**

Example: 80 kBtuh x 21.7 CFM/kBtuh = 1,736 CFM Airflow

Remember: 80,000 Btuh = 80 kBtuh



EXAMPLE OF A GAS FURNACE NAMEPLATE
SHOWING HEATING CAPACITY (OUTPUT) OF 80,000 BTUH

GAS FURNACE METHOD B—FLOOR AREA DEFAULT

When the **furnace** nameplate is inaccessible or unreadable/missing and it is a CSD duct sealing job only, use the Floor Area Default equation below:

Step D-1: Measure and calculate sq. ft. of the conditioned space. Use interior or exterior dimensions, and round to nearest foot or half-foot.

Step D-2: Calculate Estimated System Airflow in CFM using Equation F-4.

(**____ sq. ft.** conditioned area) x (**0.942**) = Airflow in **CFM**

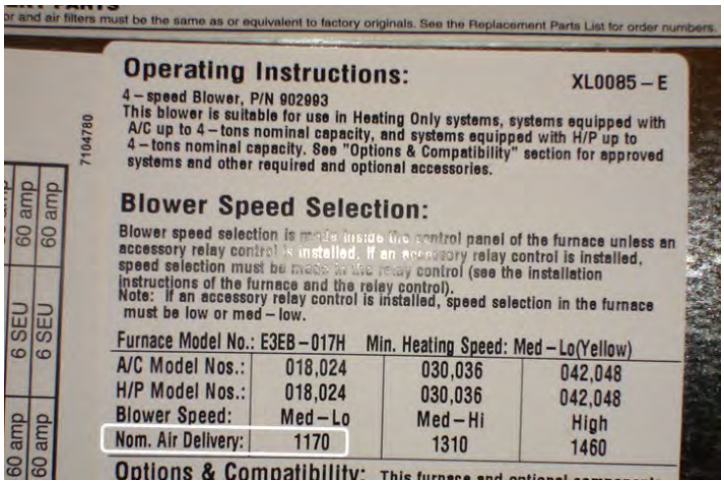
Example: 1,500 sq. ft. house x 0.942 = 1,413 CFM Airflow

ESTIMATING AIRFLOW—ELECTRIC FURNACES

For electric furnaces, there are three methods to estimate the airflow. Remember: When the HVAC unit is a package unit (combination heating and air conditioner), you must estimate CFM for both heating and cooling, but will only use the higher CFM to calculate the Start and Stop readings. Use the result these Methods (to fill in the "Airflow (units) x (CFM/unit)" box on the "5.5.3 AIRFLOW AND START/STOP CALCULATION WORKSHEET."

ELECTRIC FURNACE METHOD A—NOMINAL AIR DELIVERY ON AIR HANDLER LABEL

Step A-1: Find "Nominal Air Delivery" in CFM from the air handler manufacturer label. (Note: For multi-speed blowers, use the low speed. Heat-only units are usually wired for operation at low speed). If the label or data is missing, use Method B or Method C.



or and air filters must be the same as or equivalent to factory originals. See the Replacement Parts List for order numbers.

Operating Instructions: XL0085 – E

4 – speed Blower, P/N 902993

This blower is suitable for use in Heating Only systems, systems equipped with A/C up to 4 – tons nominal capacity, and systems equipped with H/P up to 4 – tons nominal capacity. See "Options & Compatibility" section for approved systems and other required and optional accessories.

7104780

Blower Speed Selection:

Blower speed selection is made inside the control panel of the furnace unless an accessory relay control is installed. If an accessory relay control is installed, speed selection must be made in the relay control (see the installation instructions of the furnace and the relay control).

Note: If an accessory relay control is installed, speed selection in the furnace must be low or med – low.

Furnace Model No.: E3EB – 017H	Min. Heating Speed: Med – Lo(Yellow)		
A/C Model Nos.:	018,024	030,036	042,048
H/P Model Nos.:	018,024	030,036	042,048
Blower Speed:	Med – Lo	Med – Hi	High
Nom. Air Delivery:	1170	1310	1460

Options & Compatibility: This furnace and optional accessory

60 amp | 6 SEU | 60 amp

60 amp | 6 SEU | 60 amp

ELECTRIC FURNACE METHOD B—HEATING CAPACITY ON APPLIANCE NAMEPLATE

Step B-1: Find heating Output when listed on the appliance nameplate/label as Btuh or kW (kilowatts).

Step B-2: If kW is listed, convert to CFM using this equation:

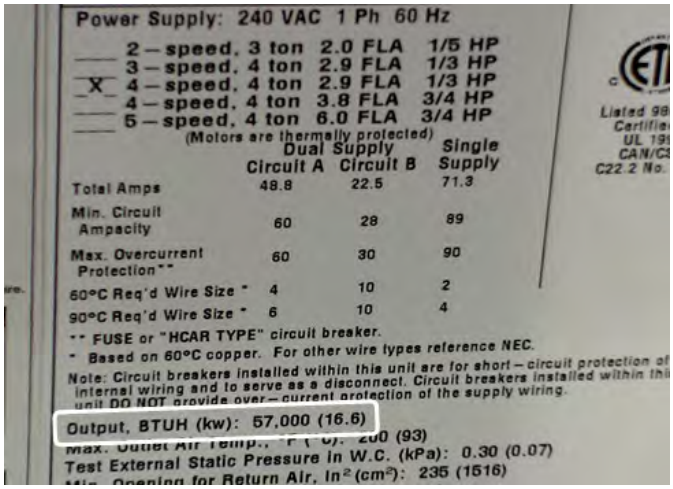
(**kW**) **x** (**74.1**) = Airflow in CFM

Step B-3: If **Btuh** is listed, convert to CFM using this equation:

(**Btuh ÷ 1000**) **x** (**21.7**) = Airflow in CFM

Step B-4: If **kBtuh** is listed, convert to CFM using this equation:

(**kBtuh**) **x** (**21.7**) = Airflow in CFM



ELECTRIC FURNACE METHOD C—MODEL NUMBER CLASSIFICATION

This Method is used for heat-only units, when KBtu or CFM is not shown on the nameplate, but can be determined directly from the manufacturer.

Step C-1: Locate model number on electric furnace nameplate/label.

Step C-2: When additional manufacturer technical data is required to calculate Estimated System Airflow, obtain contact information from the nameplate/label.

Step C-3: Use the model number to check on the manufacturer's website for information about that blower's CFM rating. If necessary, convert from Btuh or kW unit to CFM, using the conversions in Method B above.

TABLE 7.2.2: CONTACT INFORMATION FOR SOME ELECTRIC FURNACE MFRS.

Manufacturer	Web Address	Telephone Number
Coleman	www.colemanac.com/contact_us.asp	800-231-4822
First Company	www.firstco.com/	214-388-5751
Nordyne	www.intertherm.net/IMHDL.htm www.millerac.com/MMHDL.htm	Contact a distributor (numbers at website)

5.6 STEP 3: SET UP THE HOME

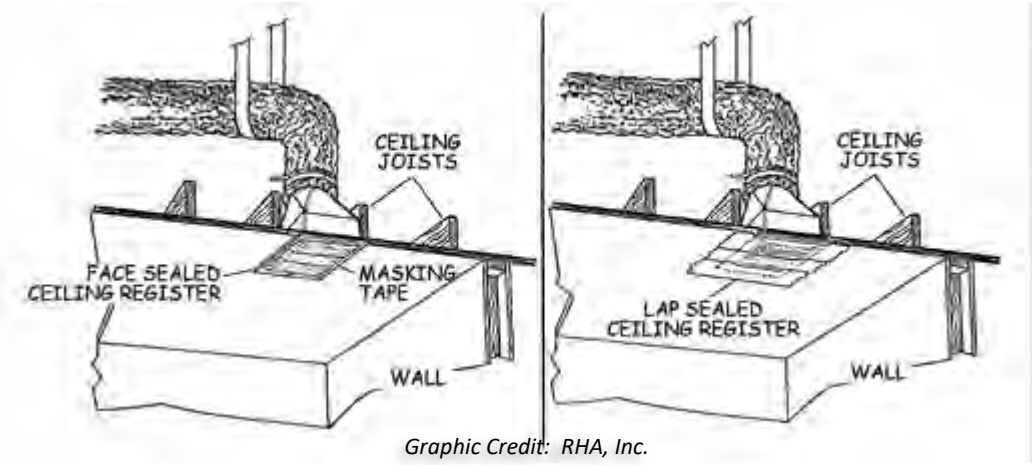
To perform a Duct Leakage test properly, all homes shall be set-up according to the following checklist:

TABLE 5.6: STEPS TO SET UP THE HOME

Item	Set-Up Task
1.	**Operate the HVAC system briefly to determine that the FAU functions properly.** • Duct testing shall not be performed if the FAU is inoperable, or a CAS Hazard is present (e.g., burner/flame abnormality, high CO, cracked heat exchanger, spillage). • Conduct a tactile check of the airflow at each supply register with air handler operating.
2.	**Temporarily block/seal intakes connected to the duct system (e.g., makeup air duct, economizer venting damper, etc.).** • A notation that it was blocked shall be made in the Duct Leakage Data Sheet, so that the inspector knows that it was blocked, and can check to make sure that it was returned to the standard state (unblocked).
3.	**If a damper is present to isolate a FAU and evaporative cooler that share the duct system, close damper during duct testing.** • If not present, or cannot be closed, duct test is not feasible.
4.	**Turn off all fan-equipped appliances, such as:** • HVAC equipment: FAU and room air conditioners. • Exhaust devices: Fans and clothes dryer vented outdoors.
5.	**Remove air filters from the duct system.** • Seal openings (slots) for slide-in filters in the plenum (e.g., with temporary tape).
6.	**Block duct system terminals as applicable.** • Seal all supply registers and return grilles with masking tape or plastic film to achieve a complete seal during duct pressurization tests as described below. • Do not block one return grille or air handler access for installation of duct tester.
	Methods to Block Supply and Return Registers
	Method 1: Face Seal Register/Grille • The face of the supply register or return grille is covered with a temporary barrier material (register-sealing film, wide masking tape, etc.). • Barrier material is restricted to the face of the register/grille and shall cover and seal all openings.

Item	Set-Up Task

Method 2: Lap Seal Register/Grille

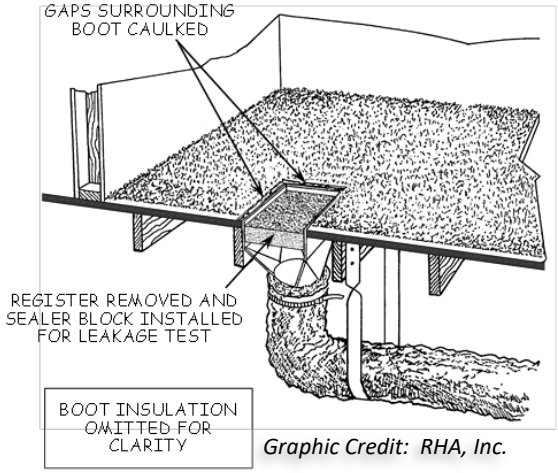


Graphic Credit: RHA, Inc.

- The register/grille shall be completely covered with temporary barrier material that laps onto the surrounding surface.
- This method shall not be used where acoustical texturing is present and where barrier material is likely to peel off paint or otherwise damage the surface.

Method 3: Cover Pan Method

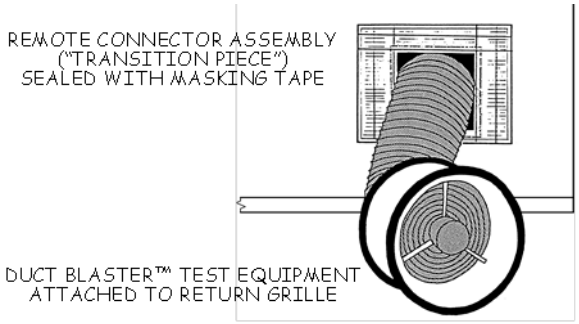
- The register opening is covered with a sealed pan-shaped device held firmly in place.
- The edge/flange of the cover pan shall be gasketed to achieve a complete seal.
- This method shall not be used where acoustical texturing is present.



Graphic Credit: RHA, Inc.

Method 4: Internal Blocking Method

- The boot is internally blocked with a temporary plug or dam (e.g., a tight-fitting block of dense foam or duct board).
- Plug shall seal the boot completely.
- Seal/caulk gaps between the boot and the structure if this method is used.

Item	Set-Up Task
7.	**Install Duct Tester Fan** • Attach the Duct Blaster® fan housing or remote connector assembly (e.g., transition piece) to the HVAC system. • Attach the remote connector to the return grille that is largest and closest to the air handler (minimum 1'x1' grille required). • When connection to a return grill is not feasible on a multi-return system (e.g., more than one central return, or a return in every room), attach the fan/remote connector to the air handler blower access opening. • Secure the fan/connector and seal completely with temporary tape/film. • Install the duct-pressure sampling tubing/probe from the digital pressure gauge to inside the taped register nearest the supply plenum. • Install the fan pressure tubing from the digital pressure gauge to the duct tester fan pressure tap.  *Graphic Credit: RHA, Inc.*

5.7 STEP 4: WORK INCREMENTS

When a duct test is feasible, Installers shall set-up the home for testing and follow this incremental work procedure. This protocol aligns with Title 24 requirements for Total Leakage Testing (i.e., to seal, shall have leakage of at least 16% of airflow and seal to 15% or less). If "Leakage to Outside" testing will be performed, see additional details in this Appendix.

CSD has divided duct leakage activities into three priority levels as outlined in the CSD 706 form:

5.7.1 Catastrophic Leaks

5.7.2 High-Pressure Leaks

5.7.3 Low-Pressure Leaks

Installers shall conduct an Initial Test, then seal all catastrophic duct leaks (priority level 1).

- An incremental duct test shall be conducted.
  - If the incremental test shows leakage less than the Duct Leakage Target, duct sealing work shall STOP.
  - If the incremental test result shows duct leakage to be at or above the Duct Leakage Target, installers shall seal all high-pressure leakage items (priority level 2).
- After high-pressure leaks are sealed, the next incremental test is conducted.
  - If the incremental test shows leakage less than the Duct Leakage Target, duct sealing work shall STOP and the reading becomes the final duct test reading.
  - If the incremental test result shows duct leakage to be at or above the Duct Leakage Target, installers shall seal all low-pressure leakage items (priority level 3).
- Work is complete when the duct system's total leakage is equal to, or less than, the Duct Leakage Target.

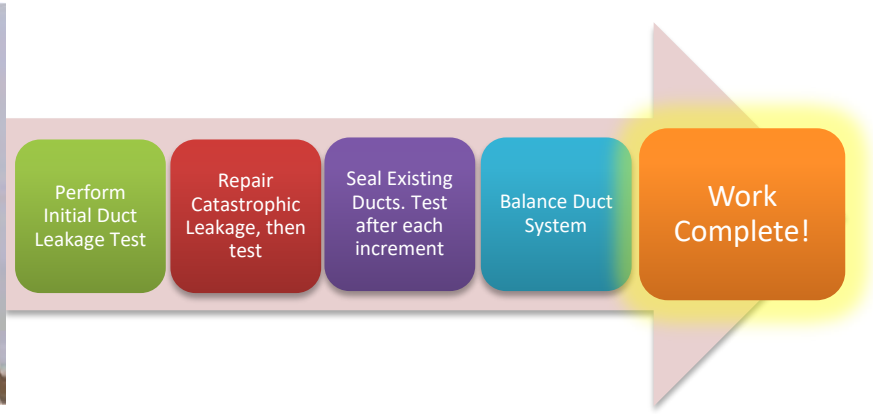
5.8 STEP 5: BALANCING THE DUCT SYSTEM

When tight-fitting doors are likely to cause excessive room pressurization, a digital gauge shall be used to detect and measure that pressure. Crews shall test duct systems to ensure adequate air movement throughout the living space with interior doors closed.

- Guidelines for room-to-room air testing shall be followed as set forth in the CAZ section of the CSD TRM, Appendix A.
- Pressures will be measured with the furnace fan operating across interior doors that can be closed and have a supply and/or return behind them.
- Rooms should not exceed 3 Pascals of pressure.
- Pressure testing will be performed with all interior doors closed and the air handler running.

The duct testing and sealing procedure is now complete.

Photo Credit: WAPTAC.org



6. Critical Duct Leakage Areas

6.1 CATASTROPHIC LEAKAGE

"Catastrophic duct leak" repairs shall be made as long as no unresolvable CAS or IAQ fails are present. Some examples of catastrophic leaks include unlined platform returns, crushed or disconnected ducts, incomplete duct systems, visible holes through the duct material that allow the escape of conditioned air, or for mobile homes, the presence of a belly return.

In order to be correctly justified and pass inspection, photographs of the catastrophic leak conditions shall be provided to show adequate leakage. Catastrophic leak repairs shall return the ducts to a normal safe and secure condition. **Sections 6.1.1- 6.1.3 describe sealing of three standard catastrophic leakage conditions.**

"Catastrophic Duct Leakage" is a condition identified when the duct tester is in "Open Mode" and speed control is at maximum, and a duct pressure no greater than 24 pascals is achieved.

6.1.1 Sealing of Unlined Platform Returns

For a platform return beneath an FAU in a hallway enclosure:

- Access the interior of the platform through the filter grille opening (grille frame may be removed to maximize size of the opening).
- Line all open stud cavities by installing fiberglass duct board as described and required in CSD TRM Section 8 (Ducting Repair, Sealing, and Insulation).

For a platform return beneath an FAU in a garage:

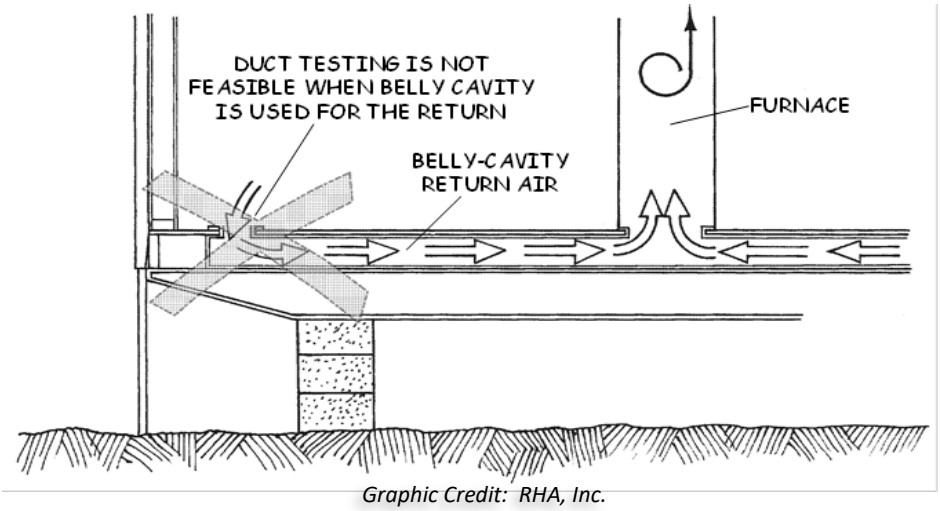
- Attempt visual inspection and leak repair through the hole under the FAU.
- Repair a leaky return starting collar from under the house, when that provides easier access.
- It is also acceptable to remove and replace a section of sheetrock in the platform from inside the garage.
- Lining with fiberglass duct board applies only to stud cavities that are open to the attic (no top plate).

6.1.2 Mobile Home with a Belly Cavity Return

Because belly cavity returns are considered a major catastrophic duct leak in a mobile home, whenever feasible, an un-ducted belly-cavity return, shall be:

- Abandoned, by removing floor registers and filling/sealing the holes, and
- Replaced by a ducted central return.
- Ducted central return air opening will be provided to the furnace closet (e.g., replaced louvered door or installation of grilles); whenever possible.
- A continuous and adequate return air pathway to the air handler will be installed.

- Manufacturer specifications shall be followed for the amount needed and be in accordance with ANSI/ACCA 1 Manual D Residential Duct Systems.



Graphic Credit: RHA, Inc.

6.1.3 Register Located in Unconditioned Space

A supply or return register shall be sealed off when it is located in a normally unconditioned space, such as an appliance enclosure, attached garage, or basement.

- When that is not practical, the register boot can be removed, and the open end of the branch duct can be closed with a sheet metal cap that is attached with screws and sealed with metallic duct tape or duct mastic.
- Another option is to attach a metal dam inside the boot with screws, and seal it with metallic duct tape or duct mastic.
- It is not acceptable to cover the interior of the register with metallic tape or metal in lieu of blocking and sealing the duct itself.

7. Detailed Duct Leakage Test Procedure

To make the testing procedure easier, it is broken down into a step-by-step process below.

TABLE 7.1: STEPS TO PERFORM THE DUCT LEAKAGE TEST

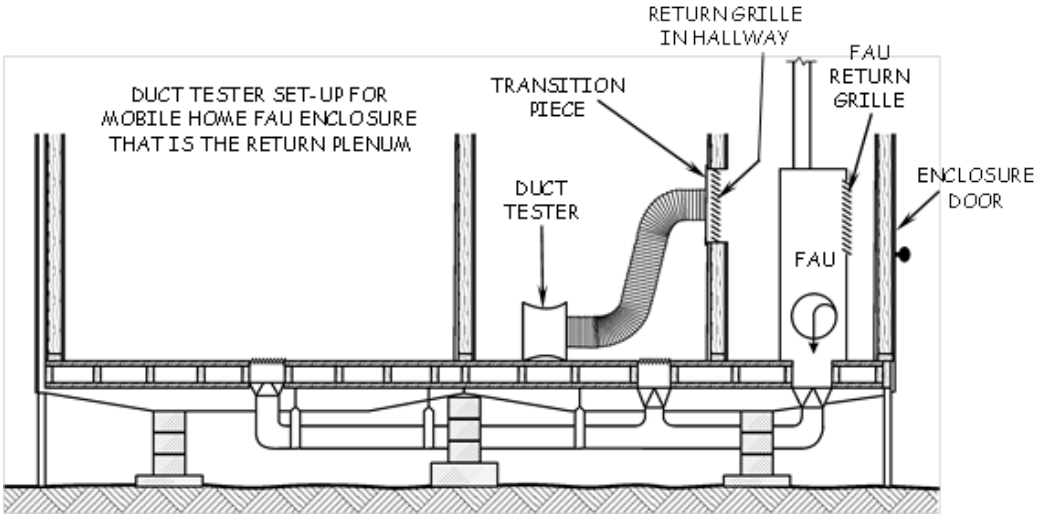
<table>
<tr><th>Item</th><th>Test Procedure</th></tr>
<tr><td>1.</td><td>Prevent depressurization of the conditioned space by the duct tester fan. Open an entrance door or large window to the outdoors.</td></tr>
<tr><td>2.</td><td>Prevent pressurization of the unconditioned space that contains the ducts (attic, crawlspace, or basement). Open vents, access cover/door, etc., as needed so that the space shall communicate with outdoors.</td></tr>
<tr><td>3.</td><td>Keep people and objects away from the front of, and at least one foot to the side of, the duct tester fan inlet during tests.</td></tr>
<tr><td>4.</td><td>Set the digital pressure Mode for one-second averaging, or as recommended by manufacturer.</td></tr>
<tr><td>5.</td><td>Set digital pressure gauge on high range, or as recommended by manufacturer.</td></tr>
<tr><td>6.</td><td>Install and use flow control devices (“flow rings”) in accordance with equipment manufacturer’s instructions.
• Duct tester fan shall be adjusted to pressurize ducts to 25 Pascals (Pa).
• The flow ring shall be changed as needed to keep Fan Pressure within an acceptable range, as indicated in Table 8.1A below for the Minneapolis Duct Blaster®.
TABLE 6.2A: FAN FLOW CONTROL
<table>
<tr><th>Fan Configuration</th><th colspan="3">Flow Range in CFM</th></tr>
<tr><td>Open Fan (no Flow Ring)</td><td>600</td><td>to</td><td>1,500</td></tr>
<tr><td>Ring 1</td><td>225</td><td>to</td><td>800</td></tr>
<tr><td>Ring 2 (smaller opening)</td><td>90</td><td>to</td><td>300</td></tr>
<tr><td>Ring 3 (smallest opening)</td><td>20</td><td>to</td><td>125</td></tr>
</table></td></tr>
</table>

	• When a Duct Pressure of 25 Pa cannot be achieved, check to ensure that the digital gauge will automatically estimate CFM at 25 Pa, or follow appropriate manufacturer's instructions for the "Can't Reach Pressure" (CRP) procedure.
7.	Measure the pressure at each register using a digital gauge, with the duct system pressurized to 25 Pa.
8.	Log the Initial Duct Leakage reading.
9.	Identify catastrophic leak locations for sealing activities, then seal all feasible catastrophic leaks. Repeat test and log reduction achieved by ceiling catastrophic leaks (priority level 1).
10.	With tester still running, identify high-pressure leak locations. • If duct leakage is still more than the Duct Leakage Target, continue sealing. • If duct leakage is at or below the Duct Leakage Target, STOP.
11.	Repeat test and log reduction achieved by high-pressure leaks (priority level 2). Identify low-pressure leak locations. • If duct leakage is still more than the Duct Leakage Target, continue sealing. • If duct leakage is at or below the Duct Leakage Target, STOP.
12.	If feasible to continue, and with tester running, identify low-pressure leak locations, then seal (priority level 3).
13.	Calculate total system duct leakage and record on CSD 706 Duct Leakage Data Sheet. • For digital pressure gauges that do not automatically convert fan pressure to fan flow, use the manufacturer's conversion tables and procedures to find Total Duct Leakage in CFM. • The automated CSD 706 form will calculate total duct leakage reduction and percentage of reduction for you. If you are using the paper form, you will need to calculate those values manually. • It is feasible that duct sealing shall reduce leakage to zero CFM25, as long as required incremental leakage reduction requirements are met.
14.	When sealing is complete, the duct system shall be balanced and provide adequate air movement throughout the living space when all room doors are closed.

7.1 ADDITIONAL TESTING PROCEDURE FOR MOBILE HOMES

7.1.1 Furnace Enclosure Used as Return Plenum

This special duct test procedure is used for mobile homes only, when the FAU is located in an enclosure accessed from outdoors and the enclosure is the return plenum (the return is not ducted into the FAU). Return air reaches the FAU through grille(s) located in the wall between the enclosure and the living space.



Graphic Credit: RHA, Inc.

7.1.2 Duct Tester Connection to Enclosure Used as Return Plenum

To perform a duct leakage test in this condition, connect the duct tester to the largest return grille in the enclosure wall, rather than directly to the FAU.

- Additional Return grille(s) shall be temporarily blocked for the test.
- Duct tester will pressurize the enclosure and FAU, not just the FAU.
- Close the enclosure access door in as-is condition (not weatherstripped before the test), unless the door is excessively damaged/deteriorated and qualifies for repair/replacement.
  - If leakage around the door is large, use the "Can't Reach Pressure" procedure.
  - If leakage is catastrophic and out of range for duct testing, the door:
- Shall be repaired before duct testing continues, or
- Temporarily blocked (e.g., with tape and plastic film).
- Sealing of gaps and cracks in the enclosure is part of duct sealing activities.

8. Clean-Up Procedure

All things changed for diagnostic/sealing work shall be returned to pre-test condition, including the following:

- Remove all temporary seals:
  - Unseal duct registers/grilles.
  - Unseal air intakes (e.g., fresh air makeup).
- Check supply registers and return grilles for proper operation.
- Reinstall or replace air filter(s):
  - Single-use: Clean dirty filter if it cannot be replaced.
  - Permanent or Reusable: Clean or replace before reinstalling.
  - Leaky Slide-in: Advise client to seal slot with temporary tape.
- Restore power to the HVAC system and/or the air handler.
- Return all windows, doors, fans, heating and cooling equipment, etc. to original settings.
- Return furniture and other household items moved during testing to the original positions.
- Remove all test equipment, tools, supplies, and trash from the home.

9. Duct Leakage Test Post-Inspection

Inspectors are responsible for analyzing the sealing choices made by a crew. Ignoring higher priority leakage areas shall result in an inspection fail for an agency and Installers. In addition to an external visual inspection, inspectors are required to visually inspect any internal repair and sealing work with a mirror (e.g., boot/riser-to-trunk connection) to ensure that sealants have been applied correctly, and all leaks are completely sealed.

In conformance with CSD TRM requirements, agency inspectors will be required to perform re-tests of diagnostic testing on a minimum of 20% of LIHEAP inspected units and 100% of DOE WAP jobs. Agencies will be required to increase the LIHEAP minimum re-test percentage when discrepancies or patterns of issues are found. Inspector re-testing shall be conducted and documented by the inspector on the appropriate diagnostic forms.

Appendix C: Shell Leakage Test Protocol

Photo Credit: CAP of San Luis Obispo

DEPARTMENT OF COMMUNITY SERVICES AND DEVELOPMENT

Effective 7/1/2023

Table of Contents

Preface

To reinforce correct shell sealing practices in the field, CSD has set a target value for infiltration reduction. This target value will measure when sealing efforts result in an acceptable outcome and ensures that all homes served under CSD's programs achieve a similar level of "tightness".

Beginning July 1, 2023, CSD will incorporate a target value of 1 CFM/sq. ft. into the existing TRM Appendix C Shell Leakage Test Protocol. This target value must be applied to all homes receiving infiltration reduction activities. The goal is to achieve no more than 1 CFM50/sq. ft of conditioned floor area. The actual leakage value (LV) is judged against the target value to answer the question, "Could we have missed shell sealing opportunities?".

As defined by this Appendix, shell sealing work is prioritized to address leaks in the following order:

- Occupant protection related sealing
- Priority 1: Interior catastrophic leaks
- Priority 2: Interior high-level leaks
- Priority 3: Interior low-level leaks
- Priority 4: Large interior mid-level leaks
- Priority 5: Small interior mid-level leaks
- Priority 6: Exterior leakage sites

When sealing all feasible leaks at these locations, the CFM reduction is calculated during incremental tests to determine if a reduction of 75 CFM[1] per technician, per hour has been met. As long as this threshold is met, sealing work will continue. Thresholds are evaluated during work and during post-inspection.

Assessment and Installation

Assessors and Installers are required to document a specific reason why every sealing opportunity listed on the CSD 704 form is not feasible using a "non-feasibility" status code. When the code is "NF-other", a written explanation is required.

To ensure that all feasible shell sealing opportunities are addressed and that the final LV is as close to the target value as possible in each home, the following steps are described in the CSD 704 form:

1. After each time interval, use the blower door reading and the dwelling square footage to calculate the LV.
2. Compare the LV to the target value. If 1 CFM50/sq. ft. is not achieved, are there any opportunities that may have been missed?

[1] Blower door readings are read in "CFM" or cubic feet per minute.

3. After sealing all feasible opportunities or when the 75 CFM per person, per hour is no longer met, calculate the final LV.
    - If the final LV is 1 CFM50/sq. ft. or less, the goal is met.
    - If the final LV is greater than (>) 1.15 CFM50/sq. ft., additional action is needed. See the CSD 704 Instruction Sheet and the steps detailed below.

Post-Inspection

Inspectors will be required to evaluate the quality of decision-making by the Assessors and Installers and document when work does not conform to the Appendix C protocol. During their retest procedures, Inspectors must calculate a LV using the "retest" blower door CFM reading, and compare their LV to the target value. If the final LV is > 15% above the target value, the inspector must verify that all required components of the CSD 704 form are completed and the justification for any shell sealing that was not performed is appropriate.

Any missed shell sealing opportunities not identified by the Assessor or completed by Installers will require documentation by the Inspector. Installers must return to the dwelling to correct any missed shell sealing opportunity and complete a new blower door test for an updated LV under the supervision of the Inspector.

Actions Required When the Target Value Is Not Met

Despite best shell sealing efforts, there may be homes where the final LV does not meet the target value of 1 CFM/sq. ft. When the final LV is >15% above the Target value (i.e., >1.15 CFM50/sq. ft.), the following procedure is required at each level of the quality control/quality assurance process.

Installers

If the final Installer LV is >1.15 CFM50/sq. ft., Installers must take photographs of each shell sealing opportunity that could not be sealed and provide an explanation in the "Assessor and Installer Notes" section of the CSD 704.

Agency Inspectors

When the Inspector LV is >1.15 CFM50/sq. ft., the agency inspector must document the following steps in accordance with TRM Appendix G on the CSD 704 form.

1. Confirm that the shell leakage testing and sealing were performed and documented correctly.
2. Confirm that shell sealing was completed based on valid assessment decisions.
3. Compare inspector test results to Assessor and Installer results. Where procedural issues are found, document the training need in the "Inspector Notes" section of the CSD 704 and provide training for field personnel.

If a pattern of missed sealing opportunities is found by the inspector, the assessor and/or installers shall receive additional on-the-job training by agency Peer Experts on the CSD shell testing and sealing protocols. If the pattern continues after on-the-job training, the agency Program Manager must submit a request through the Training Portal for field mentoring.

CSD/Third-party Inspections

During quality assurance inspections, CSD and/or their representative will document issues in writing where the CSD 704 does not adequately support shell sealing decisions, or where shell sealing opportunities were missed. When review of documentation shows misunderstanding of shell sealing policies across all field positions, CSD will assign field mentoring to identified individuals for a defined number of projects. If corrections of identified shell sealing fails are not made by the agency, the cost associated with shell testing and sealing will be disallowed.

1. Blower Door Diagnostic

Photo Credit: RHA, Inc.

1.1 WHAT IS SHELL LEAKAGE TESTING?

A shell leakage test is one of the routine checks performed by crews to analyze a home's energy efficiency. A Blower Door ™ creates pressure in a home to find any cracks or leaky areas around windows, doors, outlets, chimneys, etc. By using this process, crews can identify and seal the leaks, keeping conditioned air inside. Weatherization ensures adequate air movement throughout the living space to promote good indoor air quality.

1.2 FEASIBILITY CRITERIA

Shell leakage testing shall be performed when…

1. A doorway is suitable for installation and proper operation of shell leakage test equipment.
2. Fire or hot coals that are present in a solid fuel appliance may be safely controlled.
3. In a MUD unit, the entrance hallway communicates directly with outdoors (or an openable exterior door or window is available).

Shell leakage testing shall NOT be performed when…

1. Unfeasible according to measure feasibility criteria in the Technical Reference Manual (TRM).
2. Shell sealing is not feasible because:
   a. Dwelling is NIM.
   b. A CAS Hazard or indoor air quality (IAQ) fail exists that cannot be corrected.
   c. Extreme weather condition (e.g., very window, wet, hot, cold) prevents reliable testing or subjects occupants to unreasonable discomfort. (Note: Efforts shall be taken to reschedule test so that measures received are not restricted unnecessarily).
   d. Health or physical limitations of occupant(s) makes shell leakage test inappropriate.

   e. **[Mobile Home]** An open combustion gas-burning space heater or water heater is present that draws combustion air from the living space.
3. **[Mobile Home]** An open combustion solid-fuel burning space heater (i.e., fireplace, insert, wood stove) draws combustion air from the living space is present. CSD Exception: Pressure diagnostics and infiltration-reduction measures shall be allowed when:
   a. Pressure measurement shows the CAZ of each appliance is less negative than the HDL (see procedures described in CSD TRM Appendix A); and
   b. Installed measures do not depressurize the CAZ beyond the HDL.
4. Testing or sealing would violate CSD Health and Safety Requirements (CSD TRM Appendix E).
5. Client refuses-- after diagnostic benefits have been explained.

1.3 REQUIRED DEFERRAL

When a CAS or IAQ fail exists that cannot be corrected, one of the following consequences shall result:

- **(DOE Program or leveraged with DOE)** The dwelling shall be fully deferred.
  - **(LIHEAP only)** Limited deferral is required, and only non-infiltration reduction measures shall be installed; however, careful evaluation must be performed first to determine if non-sealing measures are achievable, reasonable, cost-effective, and it is safe for workers to enter.

1.4 CLIENT REFUSAL

If a client refuses **shell leakage** testing:

- The refusal shall be documented in the CSD 542 Deferral Form by the Assessor, with client signature and date collected from the client.
- **(DOE Program or leveraged with DOE)** A full home deferral is required.
- **(LIHEAP)** If a client refuses shell leakage testing, shell sealing shall follow the CSD 704 form.

1.5 ASBESTOS

When ACM or suspected ACM is present, shell leakage testing and sealing activities shall be in compliance with the CSD Asbestos Policy in CSD TRM Appendix E.

1.6 ORDER OF PERFORMANCE

Duct testing/sealing shall be completed before shell leakage testing of shell sealing occurs, when duct testing/sealing is feasible.

1.7 RECORDKEEPING

Diagnostic test results (when testing is conducted) and the description of work performed shall be accurately recorded on the CSD Shell Leakage Data Sheet (CSD 704). The completed data sheet shall be placed in the client's permanent file. To pass the quality control inspection, all required tests must be performed, and the CSD 704 must be completely and accurately filled out.

1.7.1 SHELL LEAKAGE TEST TYPES

Testing shall consist of:

Initial Shell Leakage Test: determines the amount of shell leakage before any sealing of catastrophic leaks begins.

Interval Tests: performed after each time increment to determine whether continued sealing work is feasible.

Final Shell Leakage Test: After completion of shell sealing, this test calculates the:

- Final shell leakage reading;
- Leakage reduction achieved; and
- Percentage of reduction achieved.

2. Equipment and Calibration Requirements

Diagnostic equipment shall be utilized, checked, and calibrated in accordance with CSD's and manufacturer's recommendations.

2.1 STANDARD TESTING EQUIPMENT

Photo Credit: WAPTAC.org

Shell leakage testing shall be performed with a standard Shell Leakage Test kit (i.e., Blower Door system) and in accordance with manufacturer's instructions, except as noted in "Alternative Testing Equipment" below. Equipment shall comply with the following requirements:

- Commercially-produced equipment shall be used.
- Digital Manometers (pressure gauges) shall be used.
- House pressure gauge shall display pascals with a range from 0 to 60 Pa, and accuracy of ±10%.
- Fan Flow gauge shall display Pascals and CFM with a range of 500 to 6000 CFM, and an accuracy of ±10%.
- Gauges may be calibrated in Inches of Water Column if the range is between 0 and 0.25 IWC with an accuracy of ±5%.
- Smoke (e.g., from an incense stick, smoke pencil, smoke puffer, etc.) with tactile tests, gauge readings, etc. shall be used in conjunction with the Blower Door as additional leak detection methods, to accomplish effective shell sealing.

2.1.1 CALIBRATION OF EQUIPMENT

Records of all calibrations and equipment checks must be kept in an equipment calibration log, as specified by CSD policy. Equipment manufacturer's technical assistance shall be used as needed to properly maintain the test equipment.

Digital gauges must be calibrated annually, by the factory, or by using manufacturer-approved field calibration procedures.

- For Minneapolis equipment, use the available field calibration plate.
- For Retrotec equipment, use items and instructions supplied with the gauge.
- Note: When Infiltration Credit will be claimed and the RESNET 800 Procedures used, additional calibration requirements must meet those in Section 6.9 of this document.
- Blower Door fans must be field-checked in accordance with the manufacturer's recommended procedures:
- Annually, or whenever a fan has been dropped or damage is suspected.
- By the factory, after damage has occurred or field checks reveal deviations that require factory service.

2.1.2 ALTERNATIVE TESTING EQUIPMENT

Alternative shell leakage testing using a **Minneapolis Duct Blaster® and Manometer** is allowed in lieu of standard shell leakage testing *only when* the fan control can produce at least 30 Pa of house pressure (MUD units only).

- The alternative test shall conform with the test requirements of both systems.
- Set the Manometer Mode to "Pressure/Flow @ 50" and the Device to "DB-B."
- If the gauge flashes "LO" and a CFM reading:
  - A flow ring with smaller opening must be installed. When fan flow is in proper range, "LO" will not appear.
  - When changing to a smaller flow ring, the "Config" setting on the gauge must be changed to match the newly installed flow ring.

3. Shell Leakage Minimum Testing Requirements

Photo Credit: WAPTAC.org

CSD recommends that Shell Leakage Testing be completed in all feasible dwellings; however, the testing minimums are outlined by program below.

3.1 DOE

Where DOE funds are used, shell testing shall consist of:

- 100% shell leakage testing.
- When a shell leakage test is *not* completed, the dwelling shall be deferred.
- Shell leakage testing is not required for MFD of 4 stories or greater.

3.2 LIHEAP

When LIHEAP is the *only* funding source used, testing shall be conducted for a minimum of:

- 20% of single-family dwellings
- 5% of multi-unit dwellings (1-3 stories).
- Shell leakage testing is not required for MFD of 4 stories or greater.

It is required that technicians conducting Shell Leakage Testing shall prioritize single-family and multi-unit dwellings, selecting these conditions first:

- Open combustion appliances that draw air from the living space.
- Solid-fuel burning appliances (fireplaces, wood stoves, inserts, pellet stoves, coal-burning appliances, etc.).
- Stucco-sided dwelling exteriors.

For remaining LIHEAP-only dwellings, agencies may choose to follow the shell sealing procedure described in Section 4.3 where no shell leakage testing is required, or they may opt to apply the DOE approach to LIHEAP, as described in Section 3.1 above.

4. Interval Approach to Shell Sealing

Shell sealing measures shall be installed in the "thermal envelope" to reduce infiltration between a conditioned space and an unconditioned space.

Shell sealing measures shall NOT be installed:

- ***Between two unconditioned spaces.***
- ***Between two conditioned spaces,* except in the following circumstances*:***
  - ***In a Multi-family dwelling, it is required to seal penetrations and gaps in the walls between two dwelling units to prevent the transfer of conditioned air from one unit to another.***
  - ***When leakage to the exterior is present, as shown by blower door (most common in a ballooned-framed or open-top interior wall cavity).***

All feasible shell sealing activities shall be installed in priority order as listed on the CSD 704 Shell Leakage Data Sheet. Additional sealing requirements are as follows:

4.1 DOE

For dwellings where any DOE funding is used**:**

- Complete 'Occupant Protection-Related Sealing' before initial Shell Leakage Testing.
- Complete initial Shell Leakage Test before catastrophic leaks are sealed and record initial air leakage in cubic feet per minute (CFM) on the CSD 704 Shell Leakage Data Sheet (CSD 704)
- Seal catastrophic leaks and complete an interval Shell Leakage Test documenting CFM on the CSD 704.

Note: if there are no catastrophic leaks, complete initial Shell Leakage Test and record CFM on the CSD 704. Complete sealing activities as follows:

- Continue sealing activities following the prioritization order as listed on the CSD 704. Complete an interval Shell Leakage Test after one hour of sealing activities recording the results on the CSD 704:
  - If < 75 CFM reduction has been achieved per person for one hour, STOP shell sealing.
  - If ≥75 CFM reduction has been achieved per person for one hour, continue sealing.
- Continue this procedure of sealing with interval testing after each hour, at a minimum, until a reduction of ≥75 CFM is no longer achieved per person.
  - Interval testing may be completed more frequently than every hour.
  - 100% of dwellings shall be assessed for mechanical ventilation utilizing the CSD 540C, ASHRAE 62.2 Mechanical Ventilation Calculator. When applying the Infiltration Credit in the CSD 540C, the Blower Door reading must be taken using the RESNET 800 procedure described in Attachment 1 of this Protocol.

4.2 LIHEAP – SHELL LEAKAGE TESTING

For dwellings where only LIHEAP funding is used:

- Complete 'Occupant Protection-Related Sealing' before initial Shell Leakage Testing.
- Complete initial Shell Leakage Test before catastrophic leaks are sealed and record initial air leakage in cubic feet per minute (CFM) on the CSD 704 Shell Leakage Data Sheet (CSD 704).
- Seal catastrophic leaks and complete an interval Shell Leakage Test documenting CFM on the CSD 704.

> *Note: if there are no catastrophic leaks, complete initial Shell Leakage Test and record CFM on the CSD 704. Complete sealing activities as follows:*

- Continue sealing activities following the prioritization order as listed on the CSD 704. Complete an interval Shell Leakage Test after one hour of sealing activities recording the results on the CSD 704:
  - If < 75 CFM reduction has been achieved per person for one hour, STOP shell sealing.
  - If ≥75 CFM reduction has been achieved per person for one hour, continue sealing.
- Continue this procedure of sealing with interval testing after each hour, at a minimum, until a reduction of ≥75 CFM is no longer achieved per person.
  - Interval testing may be completed more frequently than every hour.
  - Air changes per hour (ACH) may be calculated after each interval Shell Leakage Testing to determine the 'tightness' of the building. The calculation of CFM50 to ACH is as follows:

$$\frac{\textbf{Shell Leakage CFM50 reading x 60}}{\textbf{Volume of dwelling (L x W x H)}}$$

  - Once the dwelling has reached a 'tightness' of 5 ACH or below, the dwelling **must** be assessed for mechanical ventilation utilizing the CSD 540C, ASHRAE 62.2 Mechanical Ventilation Calculator. When applying the Infiltration Credit in the CSD 540C, the Blower Door reading must be taken using the RESNET 800 procedure described in Attachment 1 of this Protocol.
  - Dwellings greater than 5 ACH are not required to be assessed for mechanical ventilation if no further infiltration reduction measures will be installed. Agencies should get as close to the 5 ACH as possible.

4.3 LIHEAP – NO SHELL LEAKAGE TESTING

Where Shell Leakage Testing is not completed, shell sealing shall be conducted as follows:

- Complete 'Occupant Protection-Related Sealing'.
- Seal catastrophic leaks.
- Complete shell sealing activities following the prioritization order as listed on the CSD 704 Shell Leakage Data Sheet.
- Agencies should give consideration towards occupant safety prior to the installation of any infiltration measures.

- Where a CAS or IAQ hazard exists that cannot be corrected within the scope of the program, dwelling shall be NIM with no infiltration measures installed.

5. House-Set-Up for Shell Leakage Test

When a Shell Leakage Test will be conducted, proper set-up of the home shall be performed in accordance with the following protocol.

SET-UP FOR ALL HOMES

Doors, Windows, and Access Covers

1.	**Close** all prime windows and storm windows.
2.	**Close** exterior doors, attic access covers, and crawlspace access covers.
3.	**Open** all interior doors to conditioned rooms.

Basement Doors

4.	**Closed** if basement is unconditioned.
5.	**Open** if basement is conditioned.

Combustion Appliances Off

6.	Heater or furnace thermostat all the way **down or in the "Off"** position.
7.	Water heater all the way **down or on "Pilot"** setting.

Solid Fuel Appliances—Fire Not Present

8.	**Close damper** on fireplace and solid-fuel stove/insert.
9.	**Close air inlets** on solid-fuel stove/insert.
10.	**Seal openings** on solid-fuel stove/insert temporarily, if necessary to avoid drawing ashes into the home (note this on the data sheet).

Solid Fuel Appliances—Fire Is Present

11.	**"Airtight" (restricted air intake) stove or insert with closable air inlets:** *Pressurization* may be possible when stove/insert has a *low* fire, but air inlets shall be closed. **Do not Depressurize.**
12.	**Fireplace or stove/insert not "airtight":** Blower door test shall not be attempted.

Exhaust Devices, Coolers, Air Conditioners

13.	**Turn off air-moving devices** that transfer air out of or into conditioned space, attic, and crawlspace. Includes exhaust fans (kitchen, bathroom, utility), clothes dryer exhausted outside, air handler, window/wall air conditioner, controllable attic and crawlspace fans, mechanical ventilation fans.
14.	**Install winter cover** on wall/window air conditioners, evaporative coolers, and whole house fan (Note: When a vent cover is not present, install a cooler vent cover as a catastrophic leakage repair).
15.	**Close dampers** on window/wall air conditioners.

16.	**Seal off** wall/window air conditioner (e.g., with plastic film), if the unit or surround leaks air and the unit is removed during winter.
17.	**Seal off air opening** of continuously-operating mechanical ventilation fans (and note on data sheet).
18.	**Seal off fan inlet**, when exhaust fan has a functional backdraft damper. • *Pressurization only*; does not apply when depressurizing.
19.	**Do not seal fan inlet**, when exhaust fan damper is missing or does not close.
20.	**Leave open intentional openings** between conditioned and unconditioned space (such as a passive kitchen exhaust duct/vent).
21.	**Do not seal clothes dryer** exhaust opening, even if no dryer is attached (but note this on data sheet).

Plumbing Drains with P-traps

22.	**Seal or fill with water**, if empty.

SET-UP FOR HOMES WITH FAU & DUCTS

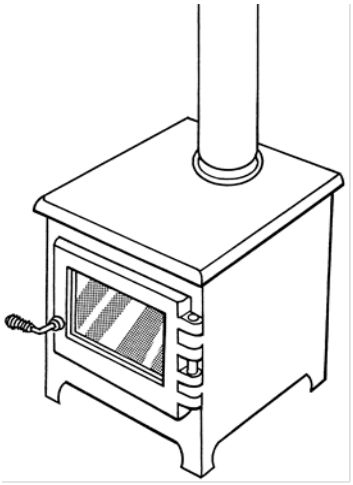
23.	**Duct Repair and Sealing** shall be completed first—before Blower Door testing is conducted.
24.	**Leave open registers/grilles (supply and return)—NORMAL CONDITION**, when: • Sealed ducts can be pressurized to 25 Pa (duct leakage is not excessive, and unsolvable air quality problems are not present).
25.	**Close and block registers/grilles (supply and return)—SPECIAL CONDITION**, when: • Sealed ducts cannot be pressurized to at least 25 Pa (duct leakage is excessive), and/or • Duct repair and sealing is not feasible (e.g., extensive duct damage/degradation is present, there is asbestos-containing insulation on the ducts), which are beyond scope of program to correct).
26.	**Blocking procedure** for registers/grilles—when blocking is required, per step 25: • **Depressurization:** securely block with masking tape, masking film, tape and plastic, etc. • **Pressurization:** plastic film may be held in place with tape or magnets.
27.	**Block fresh air make-up** duct (when present on FAU return): • Block temporarily (e.g., with tape or tape and plastic). • Note that on data sheet and be sure to re-open duct after testing.

6. Conducting a Shell Leakage Test

6.1 SCHEDULING TESTS

It is important to be sensitive to the needs of the health and well-being of the client while weatherizing a home. Agencies shall reschedule blower door testing, when a condition such as one of the following is present:

- Illness in the household.
- Winter weather prevents proper pressurization test when solid-fuel appliance is present.
- Extreme weather conditions which would result in excessive client discomfort.
- Severe windy conditions prevent accurate gauge readings.



AIR INLET CONTROLS CLOSED ON WOOD BURNING APPLIANCES

Graphic Credit: RHA, Inc.

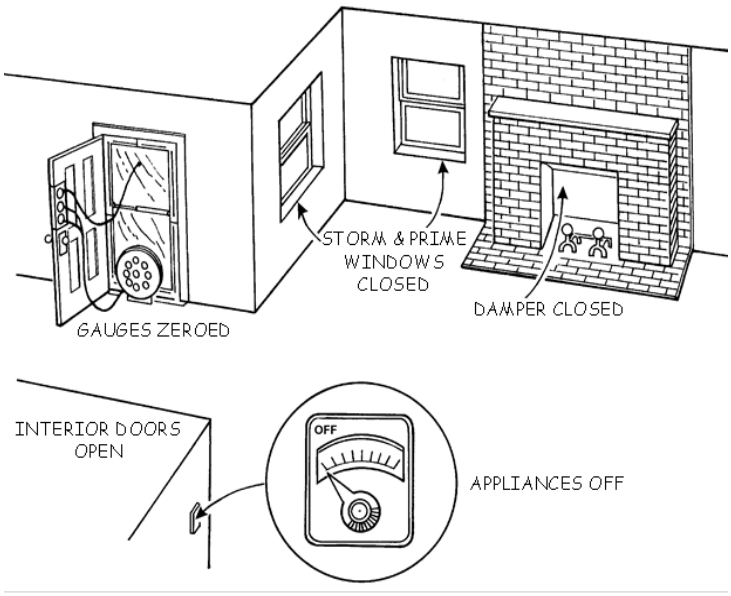
6.2 DEPRESSURIZATION VS. PRESSURIZATION

For Blower Door testing, dwellings shall be pressurized or depressurized to a standard test pressure of 50 Pa. The Depressurization technique for blower door is the standard practice used in the California weatherization program unless a condition exists that necessitates pressurization testing, as those listed below.

- Wood or other solid fuel heating fireplace or appliance is operating, or ashes/coals are present.
- Vermiculite is present in the attic, and unless asbestos-testing proves otherwise, asbestos is presumed to be present.
- Friable asbestos is found in any other area within the thermal boundaries of the dwelling.
- Animal or bird feces are found in the attic that may be a health hazard.
- Sewage leakage is found in the crawlspace.

When a home contains a solid-fuel appliance (wood/pellet stove/insert or fireplace), it shall be *pressurized* cautiously and the test must not cause an unsafe condition. All of the following applicable precautions shall be taken:

- There must be no fire or hot coals present.
- Ashes and coals must be contained and covered with a wet cloth, newspapers, etc.



Graphic Credit: RHA, Inc.

- When present for a fireplace, damper and glass doors must be closed. When not present, opening shall be temporarily sealed off (e.g., with cardboard or plastic).
- When present for a stove/insert, damper and air control must be closed.

When testing begins, a crew person shall be stationed at the appliance to signal if contaminants are being pulled from the appliance.

6.3 BLOWER DOOR TEST PROCEDURE

BLOWER DOOR TEST PROCEDURE	
1.	**Central location:** Install blower door in a centrally-located exterior doorway, with fewest obstructions within 3-feet of the fan.
2.	**Airflow to outdoors:** When Blower Door location leads to a porch, garage or other enclosed area, outside doors and/or windows in the enclosed area shall be opened enough to provide unrestricted airflow between the Blower Door and outdoors. **Multi-Family:** When Blower Door testing is performed in a MUD building with an enclosed common hallway (conditioned or not): • At least one common hallway door (or a window with adequate opening) that communicates with outdoors shall be temporarily opened during testing. • Lack of an opening to outdoors renders testing unfeasible.
3.	**Blower Door Panel and Fan:** • Install and secure the blower door fabric panel per manufacturer's instructions. • Properly orient the fan in the panel (low-flow plates facing *indoors* for depressurization) and secure it in place. • Seal off Blower Door fan in preparation for **Baseline Pressure** procedure to determine the amount of existing pressure in the dwelling. This reading is used to adjust the amount of pressure required in order to bring the dwelling to 50 Pascals **(see manufacturer's instructions because actual Baseline Pressure procedure will vary based upon gauge manufacturer and model)**.
4.	**Gauges:** • Secure the gauge on the mounting plate—which may be secured to the panel frame or a door, or may be hand held. • Install tubing per manufacturer's instructions, based on test type (depressurization or pressurization).
5.	**Outdoor tubing:** Position tubing to terminate outdoors and away from Blower Door fan turbulence. • To the side and at least 5' feet away from the fan air flow. • On the ground/surface near the edge of the foundation.
6.	**Windy condition:** Take steps to reduce the effect of wind on the accuracy of gauge readings: • Install wind dampeners per manufacturer's instructions in all tubing that terminates outdoors. • Extend outdoor tubing into a wind-protected location (shed, garage, large bucket, etc.). • Take three or more single-point readings at 50 Pa house pressure—space them a few minutes apart, during lulls when possible—then average the readings.

	• Analog Gauges: "Zero" gauges prior to each reading. • Digital Gauge: Use 5-second (or longer) time averaging.
7.	**Conduct Blower Door test** per manufacturer's instructions. Dwellings shall be depressurized to -50 Pa, and shell leakage is measured and recorded as CFM50.
8.	**House pressure less than 50 Pa:** If an initial house pressure of -50 Pa (depressurization) cannot be achieved due to large or diffuse leaks, the test equipment manufacturer's instructions and smoke testing procedures shall be followed. Follow the Blower Door manufacturer's instructions *when a digital gauge does not automatically compensate* for low pressure). • When enough shell sealing has been completed so a house pressure of 50 Pa can be achieved, CFM_{50} leakage measurements are thereafter taken directly from the gauge (without making low-pressure adjustments).

7. Shell Leakage Details

7.1 CATASTROPHIC LEAKAGE

"Catastrophic Shell Leakage" is a condition where a shell location (e.g., a wall, door, window, etc.) does not function as it is intended due to degradation or damage, and it cannot be fixed/adjusted/repaired to bring it back into a properly functioning condition. These infiltration conditions are identified by a gap of at least 1/4" and meet or exceed the catastrophic leak definition below:

Shell Catastrophic Leak Definition:

When measurable as a visible, physical gap(s), a "Catastrophic Shell Leak" is defined as 5 sq. in. of leakage area calculated for a single measure location (e.g., a door, a window, etc.).

"Catastrophic leak" repairs shall be made as long as no unresolvable CAS or IAQ fails are present*. In order to be correctly justified and pass inspection, a visual identification and written description, photographs, and measurements shall be documented in the CSD 704 Shell Leakage Data Sheet, and the calculations shall be provided in writing to show adequate leakage.

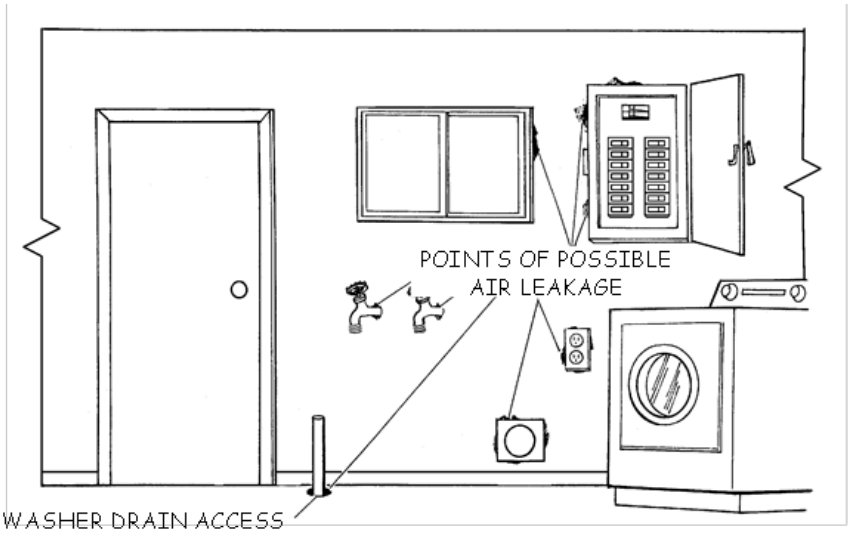
Visually-identifiable examples of catastrophic leaks include:

- Broken window (e.g., will not close completely, broken sash, broken glass, etc.).
- Broken entrance door (e.g., will not close, broken frame, hole in door, etc.).
- Interior attic or crawlspace access cover that is broken or missing.
- Missing fireplace or kitchen exhaust dampers (even if a kitchen exhaust filter is in place).
- Hole/penetration through the building shell (envelope).
- Evaporative cooler without a vent cover.

Exception: When a CAS or IAQ fail exists that cannot be corrected, one of the following consequences shall result:

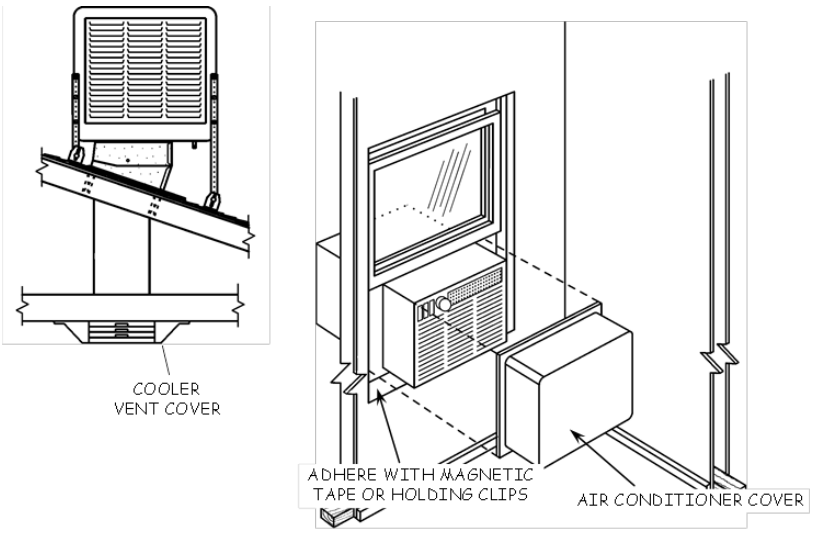
- **(DOE Program or leveraged with DOE) The** dwelling shall be fully deferred.
- **(LIHEAP only)** Limited deferral is required, and only non-infiltration reduction measures shall be installed; however, careful evaluation must be performed first to determine if non-sealing measures are achievable, reasonable, cost-effective, and it is safe for workers to enter the home.

Typical Sealing Locations



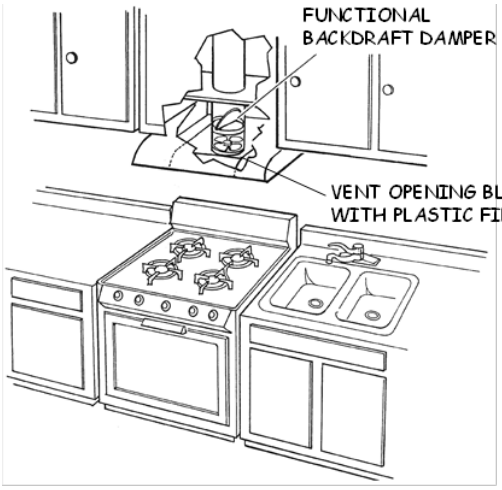
Graphic Credit: RHA, Inc.

Sealing of Cooler Vent Covers



Graphic Credit: RHA, Inc.

Temporary Sealing of Kitchen Exhaust (Pressurization Test Only)

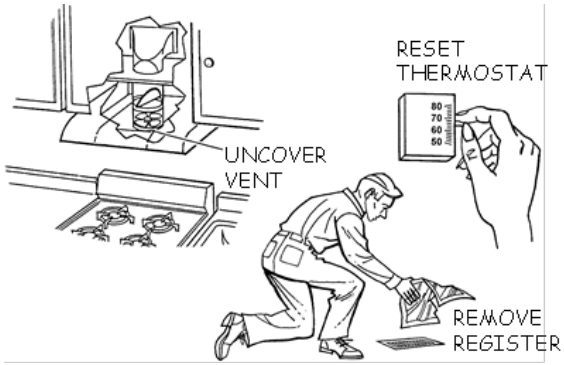


Graphic Credit: RHA, Inc.

8. Shell Leakage Test Clean-Up Procedure

All things changed for diagnostic/sealing work shall be returned to pre-test condition, including the following:

1. Relight pilot lights that were turned off or blown out.
2. Reset thermostats on space and water heating appliances.
3. Remove all temporary seals:
   - Duct registers/grilles and exhaust fans unsealed.
   - Evaporative cooler and air conditioner covers removed.
   - Air intakes (e.g., fresh air makeup) unsealed.
4. Check supply registers and return grilles for proper operation.



Graphic Credit: RHA, Inc.

5. Reinstall or replace air filter(s):
   - Single-use: Dirty filter shall be cleaned if it cannot be replaced.
   - Permanent or reusable: Cleaned before reinstalling if it is not feasible to replace.
   - Leaky slide-in: Advise client to seal slot with temporary tape.
6. Restore power to the HVAC system and/or the air handler.
7. Return all windows, doors, fans, room air conditioners, etc. to original settings.
8. Return all furniture and other household items moved during testing to original position.
9. Reset dampers and air controls on wood stoves.
10. Remove all test equipment, tools, supplies, and trash from the home.

9. Post-Inspection of Shell Sealing Work

Inspectors are required to verify that field personnel did not miss any feasible shell sealing activities and followed the Shell Leakage Testing and Sealing protocol in order to "pass" post-inspection.

In conformance with CSD TRM, agency inspectors will be required to perform re-tests of diagnostic testing on a minimum of 20% of inspected units. Agencies will be required to increase this minimum re-test percentage when discrepancies or patterns of issues are found. Inspector re-testing shall be conducted and documented by the inspector on the appropriate diagnostic forms.

Inspectors are responsible for analyzing the sealing choices made by Installers. Ignoring large leaks, and sealing quicker and easier small leaks first, shall result in an inspection fail for an agency and crews.

Appendix C Attachment 1:

RESNET 800 Procedure

10. Attachment 1: Conducting the RESNET 800 Blower Door Test

When a Blower Door test is used to calculate the Infiltration Credit for Mechanical Ventilation (CSD TRM Section 12), set-up and testing shall be performed in accordance with the following (additional) RESNET 800 procedures.

- **First**, set up and operate the Blower Door as described in Section 6.5.
- **Then** follow **Steps 1-8** in the Worksheet on the following pages.

The Worksheet is the "Test Form" referenced in the Energy Conservatory "Quick Guide", which follows. It is included to clarify what data must be collected and recorded. **Enter the final specified Blower Door reading in the applicable field of the CSD 540C for the Infiltration Credit.**

RESNET 800 Equipment Calibration Requirements

- In order to be in compliance with the RESNET 800 standard, blower doors and gauges shall be calibrated annually by: (a) the equipment manufacturer, or (b) a HERS Rating Provider or certified HERS Rater.
- Magnehelic gauges shall be calibrated only by the equipment manufacturer.
- Equipment calibration records shall be maintained in a written log for a period of three years.

RESNET 800 ONE-POINT AIR TIGHTNESS TEST		NOTES
1.	Temperatures and Elevation: Record the following: • Indoor and outdoor temperatures (to an accuracy of 10°F), and • Altitude of the home (to an accuracy of 2,000 feet).	**Temperature:** **Altitude:**
2.	Time Averaging: Choose and record time averaging of at least 10 seconds.	**Time Averaging:**
3.	Determine Level of Accuracy: Determine blower door test "Level of Accuracy": • With fan sealed off, measure and record five (5) Baseline Pressure readings (guidelines in this Appendix). • Subtract the smallest baseline measurement from the largest, and record this value as the Baseline Range.	**Readings:** **1.** **2.** **3.** **4.** **5.** **Baseline Range:**
4.	Apply Level of Accuracy: Use findings in Step 3 and this table to determine what to do.	
5.	Conduct One-Point Blower Door Test: • Use PR/FL @ 50 Mode (using DG-700 Digital Gauge; see guidelines in Attachment 1 to this Appendix). • Use the Baseline feature, measure baseline pressure for 10 seconds, then press ENTER. • Unblock the fan, and adjust speed to achieve House Pressure of 50 Pa approximately (or use Cruise Control). • Change Time Averaging to 10 seconds. • Read and Record the Induced Building Pressure[2] (Channel A) and "Nominal CFM_{50}" fan flow (Channel B). • Change fan configuration as needed (Open Fan or Low-Flow plate installed), based on fan flow CFM.	**Induced Bldg. Pressure:** **Nominal CFM50:** **Fan Configuration:**

Baseline Range	Level of Accuracy	What To Do
<5 Pa	Standard	No adjustment is required.
5 Pa to 10 Pa	Reduced	In this range, an attempt to improve the level of accuracy may be made by repeating the baseline test *using a longer time averaging period*.
>10 Pa	Invalid Test	A one-point airtightness test shall not be performed.

Induced Building Pressure = unadjusted Building Pressure ("House Pressure") minus the Pre-Test Baseline Pressure (which is determined automatically by the DG-700). A one-point test is valid only when the Induced Building Pressure is at least 15 Pa and greater than four times the Baseline Pressure. If the Induced Building Pressure is too low, test results shall not be used for the Infiltration Credit calculation for Mechanical Ventilation.[3] If using The Energy Conservatory blower door automation software (e.g., TECTITE 4.0), you can obtain the unabridged Quick Guide, that includes automation steps, from the Energy Conservatory website:

RESNET 800 ONE-POINT AIR TIGHTNESS TEST		NOTES
	• Record the fan configuration that was used to obtain the "Nominal CFM_{50}" fan flow reading.	
6.	**Record** the following information: (a) Blower Door model and serial number, and (b) digital gauge model and serial number. **Model Number** / **Serial Number** Blower Door Digital Gauge	
7.	Determine if "Nominal CFM_{50}" must be corrected to calculate "Corrected CFM_{50}." • If outside temperature is >30 °F higher than indoors, use the Temperature Correction Factor (TCF). - TCF = value in the applicable table below (Step 8) • If site altitude is >5,000 feet, use the Altitude Correction Factor (ACF). - ACF = 1+ [0.000006 x altitude (ft.)] • Equation: Corrected CFM_{50} = (Nominal CFM_{50}) x (ACF) x (TCF). - When a factor is not applicable, insert "1" into the equation for that factor. - When a correction is made, record the Corrected CFM_{50} at the right.	**Temp. Correction Factor:** **Alt. Correction Factor:** **Corrected CFM50:**
8.	Temperature Correction Factors Procedure: 1. In this Attachment, use Table 1 for Depressurization Blower Door testing. Use Table 2 for Pressurization testing. 2. Find the inside temperature along the top of the table. Then go down that column to the row representing the outside temperature. 3. The value in that cell is the Temperature Correction Factor used to adjust the "Nominal CFM_{50}" (in Step 7). 4. When actual temperature is not shown, round up or down to the nearest 5°F. ►Example: For 72°, use the 70° column. For 73°, use the 75° column.	

http://www.energyconservatory.com/support/manuals
In the Blower Door section, click on the link to "Quick Guide—RESNET One Point Test."

Quick Guide for Performing a Blower Door Test per RESNET 800 Using a DG-700 Digital Gauge

This abridged Quick Guide is for performing a Blower Door test without automation that is in conformance with the RESNET 800 Standard.[3] Contents are used with permission from The Energy Conservatory.

Quick Guide

Collecting Data for a Manual RESNET One-Point Airtightness Test

If you are manually collecting data for a RESNET One-Point Airtightness Test, in accordance with Chapter 8 of the RESNET Standards (adopted in 2012), follow the Quick Guide procedures below. The last page of this guide includes a form for you to record the test data.

The RESNET One-Point test requires that a series of 5 pre-test baseline building pressure readings be taken, using a time-averaging period of at least 10 seconds. From these 5 baseline readings, the RESNET test standard has you calculate a Baseline Range (defined as the largest baseline reading minus the smallest baseline reading). The calculated Baseline Range is then used to determine the accuracy level of the test:

- **Standard Accuracy** Test (Baseline Range less than 5.0 Pa)
- **Reduced Level of Accuracy** Test (Baseline Range between 5.0 and 10.0 Pa)
- **Invalid** Test (Baseline Range greater than 10.0 Pa)

If your test is classified as **Reduced Level of Accuracy** or **Invalid**, you may repeat the test and increase the time averaging period, or use one of the other approved RESNET test standards (multi-point test or repeated single-point test).

A. Collecting the 5 Pre-Test Baseline Measurements – Determining Test Accuracy Level

1. Prepare the building and install the Blower Door system and DG-700 gauge for a standard airtightness test.
2. Turn on the DG-700 gauge by pressing the **ON/OFF** button. Leave the gauge in the default **PR/PR** Mode

3. Press the **BASELINE** button once to initiate the baseline pressure measurement feature. The word "BASELINE" will begin to flash in the **Channel A** display, indicating that the baseline feature is active. At this point, the gauge is monitoring the real-time **Channel A** pressure reading, but is not recording the reading. The **Channel B** display is not active at this time.

[3] If using The Energy Conservatory blower door automation software (e.g., TECTITE 4.0), you can obtain the unabridged Quick Guide, that includes automation steps, from the Energy Conservatory website: http://www.energyconservatory.com/support/manuals
In the Blower Door section, click on the link to "Quick Guide—RESNET One Point Test."

4. With the fan inlet covered and the fan off, press the **START** button to begin the first baseline pressure measurement. Once the **START** button is pressed, the word "BASELINE" stops flashing and the gauge begins displaying a ***long term average*** baseline pressure reading on **Channel A**. During the baseline measurement procedure, the **Channel B** display is used as a timer to let the user know how long (in seconds) the baseline measurement has been active. Once the timer on **Channel B** reaches 10 seconds, record the first baseline reading from **Channel A** in **Section A** of your **Test Form** (-2.6 Pascals in the example below). **Note:** Be sure to include the sign of the baseline readings (i.e. positive or negative).

5. Once you have recorded the first baseline reading, press the **START** button again to clear the gauge and begin a second baseline reading. Record the second baseline reading after the timer reaches 10 seconds. Continue pressing the **START** button and recording your baseline readings until you have collected all 5 readings.

6. After you have collected the 5 baseline readings, press the **CLEAR** button to turn off the baseline measurement feature.

7. Complete **Section A** of the **Test Form** to determine the Accuracy Level of your Test. If your test is classified as **Reduced Level of Accuracy** or **Invalid**, you may repeat the test and increase the time averaging period, or use one of the other approved RESNET test standards (multi-point test or repeated single-point test).

B. Completing the One-Point Test

Conduct a standard one-point CFM50 test using both the **BASELINE** and the **PR/FL @50** features on the DG-700 gauge. Follow the instructions in TEC's Quick-Guide **BD-DEP700-CR**.

- Use the **PR/FL @50** Mode
- Use the **BASELINE** feature and be sure your baseline pressure reading is taken for 10 seconds before pressing the **ENTER** button.
- Once you have adjusted the fan and achieved a building pressure of approximately -50 Pascals, change the Time Averaging feature to **10 seconds.** Now record the ***Induced Building Pressure*** (**Channel A**) and ***Nominal CFM50*** (**Channel B**) in **Section B** of the Test Form.
- Fill out **Section C** of the **Test Form**. Use the charts attached to the **Test Form** to manually adjust for temperature and site elevation (if required).

C. Using a Longer Time Averaging Period

If you need to repeat your test with a longer time averaging period, follow these guidelines.

- Use a longer time period in **Section A** above when collecting your baseline readings.
- Use the Long-Term average setting rather than the 10 Second average setting in the **Section B** above.
- Once you are in the Long-Term average setting, press the **START** button to clear the gauge readings and start a new long-term average measurement.
- After pressing **START**, use a stop watch to keep track of the length of time of each measurement so that the measurement times are the same as those used to record the baseline readings in **Section A**.

Temperature Correction Factors

(Use only when outside temperature is >30°F higher than the inside temperature)

Procedure:

1. Use **Table 1** for **Depressurization** blower door testing. Use **Table 2** for **Pressurization** testing.
2. Find the **inside temperature** along the top of the table. Then go down that column to the row representing the **outside temperature.**
3. The value in that cell is the **Temperature Correction Factor** used to adjust the "Nominal CFM_{50}" (see RESNET One-Point Airtightness Test Form, Section B).
4. When actual temperature is not shown, round up or down to the nearest 5°F. Example: For 72°, use the 70° column. For 73°, use the 75° column.

Table 1

Correction Factors for Depressurization Testing

OUTSIDE TEMP (F)	50	55	60	65	70	75	80	85	90
-20	0.865	0.861	0.857	0.853	0.849	0.845	0.841	0.837	0.833
-15	0.874	0.870	0.866	0.862	0.858	0.854	0.850	0.846	0.842
-10	0.883	0.879	0.874	0.870	0.866	0.862	0.858	0.854	0.850
-5	0.892	0.887	0.883	0.879	0.875	0.871	0.867	0.863	0.859
0	0.900	0.896	0.892	0.887	0.883	0.879	0.875	0.871	0.867
5	0.909	0.905	0.900	0.896	0.892	0.888	0.883	0.879	0.875
10	0.918	0.913	0.909	0.905	0.900	0.896	0.892	0.888	0.884
15	0.927	0.922	0.918	0.913	0.909	0.905	0.900	0.896	0.892
20	0.935	0.931	0.926	0.922	0.917	0.913	0.909	0.905	0.900
25	0.944	0.939	0.935	0.930	0.926	0.922	0.917	0.913	0.909
30	0.952	0.948	0.943	0.939	0.934	0.930	0.926	0.921	0.917
35	0.961	0.956	0.952	0.947	0.943	0.938	0.934	0.930	0.925
40	0.970	0.965	0.960	0.956	0.951	0.947	0.942	0.938	0.934
45	0.978	0.974	0.969	0.964	0.960	0.955	0.951	0.946	0.942
50	0.987	0.982	0.977	0.973	0.968	0.963	0.959	0.955	0.950
55	0.995	0.990	0.986	0.981	0.976	0.972	0.967	0.963	0.958
60	1.004	0.999	0.994	0.989	0.985	0.980	0.976	0.971	0.967
65	1.012	1.008	1.003	0.998	0.993	0.988	0.984	0.979	0.975
70	1.021	1.016	1.011	1.006	1.001	0.997	0.992	0.988	0.983
75	1.029	1.024	1.019	1.015	1.010	1.005	1.000	0.996	0.991
80	1.038	1.033	1.028	1.023	1.018	1.013	1.009	1.004	0.999
85	1.046	1.041	1.036	1.031	1.026	1.022	1.017	1.012	1.008
90	1.055	1.050	1.045	1.040	1.035	1.030	1.025	1.020	1.016
95	1.063	1.058	1.053	1.048	1.043	1.038	1.033	1.028	1.024
100	1.072	1.066	1.061	1.056	1.051	1.046	1.041	1.037	1.032
105	1.080	1.075	1.070	1.064	1.059	1.054	1.050	1.045	1.040
110	1.088	1.083	1.078	1.073	1.068	1.063	1.058	1.053	1.048

Temperature Correction Factors

(Use only when outside temperature is >30°F higher than the inside temperature)
(cont.)

Table 2

Correction Factors for Pressurization Testing

OUTSIDE TEMP (F)	50	55	60	65	70	75	80	85	90
-20	1.062	1.072	1.081	1.090	1.099	1.108	1.117	1.127	1.136
-15	1.056	1.066	1.075	1.084	1.093	1.102	1.111	1.120	1.129
-10	1.051	1.060	1.069	1.078	1.087	1.096	1.105	1.114	1.123
-5	1.045	1.054	1.063	1.072	1.081	1.090	1.099	1.108	1.117
0	1.039	1.048	1.057	1.066	1.075	1.084	1.093	1.102	1.111
5	1.033	1.042	1.051	1.060	1.069	1.078	1.087	1.096	1.105
10	1.028	1.037	1.046	1.055	1.064	1.072	1.081	1.090	1.099
15	1.023	1.031	1.040	1.049	1.058	1.067	1.076	1.084	1.093
20	1.017	1.026	1.035	1.044	1.052	1.061	1.070	1.079	1.087
25	1.012	1.021	1.029	1.038	1.047	1.056	1.064	1.073	1.082
30	1.007	1.015	1.024	1.033	1.041	1.050	1.059	1.067	1.076
35	1.002	1.010	1.019	1.028	1.036	1.045	1.054	1.062	1.071
40	0.997	1.005	1.014	1.023	1.031	1.040	1.048	1.057	1.065
45	0.992	1.000	1.009	1.017	1.026	1.035	1.043	1.051	1.060
50	0.987	0.995	1.004	1.012	1.021	1.029	1.038	1.046	1.055
55	0.982	0.990	0.999	1.008	1.016	1.024	1.033	1.041	1.050
60	0.977	0.986	0.994	1.003	1.011	1.019	1.028	1.036	1.045
65	0.973	0.981	0.989	0.998	1.006	1.015	1.023	1.031	1.040
70	0.968	0.976	0.985	0.993	1.001	1.010	1.018	1.026	1.035
75	0.963	0.972	0.980	0.988	0.997	1.005	1.013	1.022	1.030
80	0.959	0.967	0.976	0.984	0.992	1.000	1.009	1.017	1.025
85	0.955	0.963	0.971	0.979	0.988	0.996	1.004	1.012	1.020
90	0.950	0.958	0.967	0.975	0.983	0.991	0.999	1.008	1.016
95	0.946	0.954	0.962	0.970	0.979	0.987	0.995	1.003	1.011
100	0.942	0.950	0.958	0.966	0.970	0.982	0.990	0.998	1.007
105	0.938	0.946	0.954	0.962	0.970	0.978	0.986	0.994	1.002
110	0.933	0.942	0.950	0.952	0.966	0.974	0.982	0.990	0.998

D. Energy Audit/Priority List Protocol

Table of Contents

Energy Audit/Priority List Protocol

1. PROTOCOL OVERVIEW

1.1 The California Department of Community Services and Development (CSD) adopts the following CSD Energy Audit/Priority List Protocol document for its Department of Energy Weatherization Assistance Program (DOE WAP).

1.2 This Protocol outlines the cost-effectiveness criteria to justify work scopes and energy conservation measures (ECMs) within the DOE WAP.

1.3 This Protocol enhances CSD's Technical Reference Manual (TRM), diagnostic protocols, field forms, and contractual policies. Any conflicts between this document and other program policies and standards should be brought to the attention of CSD for interpretation.

1.4 This document will be updated and approved by DOE every 5 years at a minimum.

1.5 CSD reserves the right to apply the policies contained in this document to other CSD-administered programs at its sole discretion.

2. AUDITOR MINIMUM CREDENTIALS

2.1 Dwelling audits and assessments shall be performed by an auditor/assessor or team qualified to perform these roles under the DOE WAP.

2.2 An assessment must be conducted to ensure that all health and safety concerns are identified. Information collected during the assessment will be used to form a work scope of measures to be installed.

2.3 For assessments, CSD requires that all diagnostics be conducted in accordance with the TRM, and all feasible measures must be assessed and defined on the work scope.

2.4 Data collection practices and calculations must be transparent. Energy audit and priority list decisions must be presented in a consistent manner; and persons completing this work shall be accountable for their work by adhering to protocol requirements, maintaining professional certifications, and providing quality control inspections.

2.5 Auditors/assessors conducting energy audits and producing work scopes shall have the skills, credentials, and experience required to effectively perform assessments/energy audits. If a single auditor lacks the required skills, a qualified team[1] may be assembled to complete the work scope.

2.5.1 At a minimum, the auditor/assessor shall be capable of effectively performing the following tasks:

2.5.1 (a) Energy modeling (utilizing approved software)

2.5.1 (b) Building assessment (identifying safety, code, durability and energy systems issues) and field data collection

2.5.1 (c) Diagnostic testing for energy efficiency and health and safety

2.5.1 (d) Combustion appliance safety testing

2.5.1 (e) Feasibility analysis for the installation of energy efficient building improvements and

2.5.1 (f) Construction cost estimating

2.5.2 Third-party auditors/assessors that assess dwelling units for energy purposes (including, but without limitation, mechanical systems), shall not be affiliated with any person or entity responsible for installation of measures or post-inspection of dwelling units for the DOE WAP.

[1]Audit teams may include qualified non-agency/subcontractor personnel for purposes of audits if such personnel are otherwise disinterested third parties who do not provide weatherization measure installation or inspections.

3. DOE WAP APPROVED MEASURES

3.1. Approved Materials

3.1.1 All energy conservation measures installed with DOE WAP funds must comply with the DOE 10 CFR 440, Appendix A government standards/materials list. This list is produced by the Consumer Product Safety Commission and is published in the Title 16, Code of Federal Regulations (CFR). The most recent copy of the document is found here: https://www.law.cornell.edu/cfr/text/10/appendix-A_to_part_440.

3.1.2 If a proposed measure will conflict with 10 CFR 440, Appendix A because of the requirements of the local jurisdiction, the local code will have precedence. A copy of the applicable code section must be maintained in the client file for justification.

3.2. Measure Categories

3.2.1 CSD divides measures into Health & Safety (H&S), General Heat Waste (GHW) and Energy Conservation Measures (ECM). The categories for measure installation are described more fully in the following sections.

3.2.2 Health & Safety Measures

3.2.2(a) Allowable H&S measures in the DOE WAP are those measures necessary to maintain the physical well-being of dwelling occupants and weatherization workers.

3.2.2(b) To be counted as a weatherized unit, a dwelling must receive at least one ECM in addition to the H&S measure(s).

3.2.3 General Heat Waste Measures

3.2.3(a) The GHW measures are generally cost effective, and do not require justification by energy audit. GHW materials are relatively low-cost items that are quickly and easily installed.

3.2.3(b) GHW measure costs (including labor) must not exceed $250 in total for all measures within this category.

3.2.4 Energy Conservation Measures

3.2.4(a) With the exception of H&S and GHW, all other measures in the DOE WAP are energy conservation measures, also known as ECMs. CSD divides the ECM category into two sub-categories:

3.2.4(a1) Audit-Driven Measures (ADMs) - ADMs are measures that have savings values dependent on climate region, fuel used, building type of the home in which they would be installed, and other variable factors. These ECMs are modeled in an audit tool to determine a site-specific cost-effectiveness.

3.2.4(a2) Priority List (PL) Measures - PL measures are specific by building type and are determined by DOE. Within the DOE WAP, these measures do not require an energy audit. The feasibility of the PL measures will be updated in the CSD 710 (DOE Energy Audit and Priority List Checklist) form when the DOE WAP provides updates and must be applied in the field by agencies no later than CSDs stated implementation deadline.

3.2.4(b) Feasibility of an ECM is determined by 1) Individual measure feasibility as defined in the TRM, and 2) Calculated savings-to-investment ratio (SIR). Additional information about the calculation of SIRs is provided in Developing an Audit Work Scope.

3.2.5 Incidental Repairs

3.2.5(a) There may be circumstances when an ADM or PL measure could become feasible if a repair is made to protect or preserve the measure(s).

3.2.5(a1) Example: Repair of a loose gutter would stop rain from pooling under a dwelling. The presence of the water currently prevents floor insulation from being installed by the weatherization program. Therefore, repair of the gutter is an incidental repair.

3.2.5(b) All incidental repairs must have a direct association with an ECM being installed and be necessary for the effective performance or preservation of that measure.

3.2.5(c) Many, but not all, incidental repairs are identified in the Limited Home Repair line item as defined in Section 1 General Installation Guidelines, Limited Home Repair. Some incidental repairs include, but are not limited to:

3.2.5(c1) Floor/platform repairs for heating/cooling sources or water heaters

3.2.5(c2) Cover plate installation to replace cracked/broken cover plates

3.2.5(c3) Minor roof repairs

3.2.5(c4) Mobile home skirting repairs

3.2.5(c5) Rough framing repair to support window or door installation

3.2.5(c6) Exhaust fan vent extension (except kitchen exhaust)

3.2.5(c7) Domestic clothes dryer moisture exhaust

3.2.5(c8) Makeup air installation for a domestic clothes dryer

3.2.5(d) Specific requirements for the application of incidental repairs are detailed in Incidental and Ancillary Costs in the PL Path and Incidental and Ancillary Costs in the Audit Path.

3.2.5(e) Dwellings requiring extensive repairs (most often structural or environmental) should be referred to a rehabilitation program, or the agency must use other sources of funding to cover these costs.

3.2.5(f) All proposed incidental repairs require photo documentation and a written justification that will be attached to the required energy audit reports.

3.2.5(g) Incidental repair cost(s) are tracked as a separate line item for all energy conservation measures.

3.2.5(h) It is not required for incidental repair materials to comply with applicable 10 CFR 440, Appendix A material specifications.

3.2.6 Ancillary Costs

3.2.6(a) Ancillary costs are low-cost materials that are necessary to ECM installations, but are not provided by the measure manufacturer (i.e., materials such as hardware, fasteners, adhesive, sealant, etc.).

3.2.6(b) Ancillary costs must be included in the installed measure cost, and the combined total may not exceed the measure maximum.

3.2.6(c) It is not required for any ancillary materials to comply with applicable 10 CFR 440, Appendix A material specifications.

4. DOE APPROVED APPROACH

4.1 When building the work scope for dwellings under the DOE WAP, there are two approved approaches: the Priority List path or the Audit path.

4.2 A single approach must be identified for each dwelling served. A hybrid approach is not allowed.

4.3 The path decision is directed by a set of criteria for each dwelling; not based on a “preferred” approach.

4.3.1 It is required to use the CSD 710 Energy Audit/Priority List Checklist to document dwelling conditions and the Audit path/Priority List path decision.

4.4 While the CSD 710 Energy Audit/Priority List Checklist decision may prompt the auditor to use the PL path, agencies may decide to conduct a site-specific energy audit for any dwelling.

4.5. Priority List Path

4.5.1 The PL path is allowable for single-family, mobile homes, and low-rise multi-family (LRMF) as defined in Appendix H References. When using the PL path, a prescribed set of measures are installed following a specific order as defined on the PL. Procedures for this method are described in Priority List Path Methodology.

4.6. Audit Path

4.6.1 The Audit path is required when specific conditions exist in the dwelling or certain measures may be feasible and will be billed to DOE WAP. Procedures for this method are described in Audit Path Methodology. There are two different approved audit softwares depending on the building type: REM/Design and TREAT.

4.6.2 REM/Design Audit

4.6.2(a) This audit software may be used for single-family, manufactured housing, and small multi-family buildings with 5-24 units with independent heating and/or cooling and a storage water heater.

4.6.2(b) The procedures for this method are described in REM/Design Energy Audit Procedure.

4.6.3 TREAT Audit

4.6.3(a) For small multi-family buildings with common heating and/or cooling systems, and large multi-family buildings (consisting of 25 or more units), a TREAT Audit is required to model in-unit and common area measures.

4.6.3(b) Due to the scope and expertise required to perform this type of energy audit, a qualified third-party is recommended to audit the building and identify any ECMs and H&S issues.

4.6.3(c) The TREAT audit procedure is described in TREAT Energy Audit Procedure.

4.7. DOE Dwelling Eligibility

4.7.1 66/50 Rule

4.7.1(a) Each building containing dwelling units must be evaluated and weatherized as a complete system of interconnected dwellings and systems.

4.7.1(b) To provide maximum energy savings and benefits to the residents of a building, a "whole-building approach" will be prioritized.

4.7.1(b1) When 50% of the units in a duplex or four-plex are income-qualified for weatherization (or where a unit will be occupied by low-income tenants within 180 days under a federal, state, or local government rehabilitation program), the entire building may be served.

4.7.1(b2) When 66% of the units in a triplex or building with five or more are income-qualified, the entire building may be served.

4.7.1(c) When the 66/50 rule is met, investment for the whole building (including any common area measures and in-unit measures within the building) may not exceed the number of dwelling units times the current per-dwelling average maximum. This includes income eligible, non-income eligible, and vacant units.

4.7.1(c1) Completion of the CSD 75P form is required to show that the 66/50 rule is being applied correctly.

4.7.2 Whole-Building Weatherization

4.7.2(a) The following "whole-building measures" listed below may only be considered for installation when an entire building will be served.

4.7.2(a1) Ceiling/knee wall insulation

4.7.2(a2) Common area measures: These measures must be cost-justified by energy audit and installed in common areas within the building thermal envelope of the qualified residential building).

4.7.2(a3) Cooling system energy efficiency upgrade (for a whole-building, common system)

4.7.2(a4) Floor insulation

4.7.2(a5) Heating system energy efficiency upgrade (for a whole-building, common system)

4.7.2(a6) Wall insulation

4.7.2(a7) Water heater energy efficiency upgrade (for a whole-building, common system)

4.7.2(a8) Windows for energy efficiency upgrade

4.7.3 Individual Units

4.7.3(a) Although whole-building weatherization is the preferred approach for multi-unit buildings, weatherization of one or more individual units may be permitted to be served with CSD and DOE approval.

4.7.3(b) For individual unit weatherization, CSD requires agencies to thoroughly document the reasons that whole-building weatherization is not feasible.

4.7.3(c) When individual unit weatherization will be provided, DOE WAP whole-building measures (defined in Whole-Building Weatherization) shall not be feasible.

4.7.3(d) If an individual unit in a multi-unit building will be served, the proposed individual dwelling unit must meet the following conditions:

4.7.3(d1) The unit must be self-contained, without sharing an attic or basement with adjacent units, and has its own individual heating and cooling systems, and

4.7.3(d2) The unit will be audited with a current, approved energy audit tool and protocol that is able to adequately address a single unit within a larger structure or the most current DOE multi-family priority list is applicable, and

4.7.3(d3) The work scope is specific to allowable measures within the eligible unit(s), and

4.7.3(d4) Each unit must be submitted to CSD for approval by the DOE Project Officer prior to the start of work.

4.7.4 Vacant and Over-Income Unit Rule

4.7.4(a) When vacant or over-income units are encountered, the procedures in Table D-1 shall be followed.

TABLE D-1: VACANT OR OVER-INCOME UNIT POLICIES FOR WHOLE BUILDING AND IN-UNIT WEATHERIZATION

	Single-Family (Detached)	Duplexes & Four-plexes	Tri-plexes & 5+ Units
Level of Service	Not Eligible	When at least 50% of the units are income eligible, whole building measures shall be installed and all income eligible units shall be served for in-unit weatherization. Additional units (including vacant and/or over-income units) may also be served for in-unit weatherization.	When at least 66% of the units are income eligible, whole building measures shall be installed and all income eligible units shall be served for in-unit weatherization. Additional units (including vacant and/or over-income units) may also be served for in-unit weatherization.
Funding Allowed	Not Eligible	Multiply the total number of units in the multi-unit building by the current per-dwelling unit average maximum. This will be the total funding available for weatherizing all the units (including vacant units).	
Additional Contract Policies	Not Eligible	Vacant units must be occupied by eligible low-income tenants within 180 days.	
Combustion Appliance Repair or Replacement	Not Eligible	If power is available, and all combustion appliances are CAS tested, H&S repairs/replacements may be made to the appliances of vacant and over-income units.	
Service Limitations	Not Eligible	If a dangerous indoor air quality condition, an electrical system hazard, and/or fire hazard is found to exist, agencies may ONLY disable an appliance to eliminate the immediate hazard.	

4.8. General Work Scope Considerations

4.8.1 For each dwelling weatherized in the DOE WAP, a work scope must be created and finalized. The completed work scope is comprised of all required CSD forms, photographic documentation (when required), energy bills and identification of all feasible H&S, GHW, and ECMs to be installed.

4.8.2 A lack of adequate agency training is not an allowable reason to skip measures. If training is identified, the agency shall notify CSD before jobs are postponed and adequate training is acquired by the agency.

4.8.3 To be included on a work scope, all ECMs must meet DOE WAP cost-effectiveness criteria.

4.8.3(a) Measure SIRs must be calculated by the energy audit tool for ADMs, or they are assumed to be cost effective with a Measure SIR ≥1.0 for a PL measure.

4.8.3(b) General heat waste, H&S, or other non-energy (administrative) costs shall not be included in the Measure SIR or Dwelling SIR calculations.

4.8.4 For the Measure SIR and Dwelling SIR calculations, the following shall apply:

4.8.4(a) For the DOE WAP, the discount rate applied for the "present value" calculation shall be 3%, unless otherwise communicated by CSD. Energy escalation and inflation shall not be included.

4.8.4(b) All savings calculations must be adjusted for interaction of other installed ECMs with a higher SIR.

4.8.5 Measure SIR

4.8.5(a) The Measure SIR is the ratio of present value of the measure energy savings compounded annually over the life of the measure, divided by the total installed cost of the measure given by Equation 1 below.

Equation 1: $SIR\ measure = S*((1+i)^n - 1)/(i(1+i)^n)/C$

Where: S = 1st year savings of measure ($)

i = discount rate (%)

n = effective useful life of measure (years)

C = installed cost of measure ($)

4.8.6 Dwelling SIR

4.8.6(a) The Dwelling SIR is the ratio of present value of the package savings compounded annually over the life of the package divided by the total installed cost of the package (including all WAP and all non-WAP funds).

4.8.6(b) The present value (PV) of an individual measure is shown in Equation 2.

Equation 2: $PV\ measure = S*((1+i)^n - 1)/(i(1+i)^n)$

Where: S = First year savings of measure

i = discount rate (%)

n = effective useful life of measure

4.8.7 For an ADM to be included in a final work scope, the measure must have an SIR ≥1.0 (except air sealing, by DOE WAP policy). All Priority List measures are considered cost-effective.

4.8.8 Client Refusal and Measure Skipping Overview

4.8.8(a) Skipping H&S Measures

4.8.8(a1) Feasible H&S measures shall not be skipped.

4.8.8(a2) Feasible H&S measures cannot be removed from the work scope (for client refusal or other reason), or the dwelling shall be deferred.

4.8.8(b) Skipping ECMs

4.8.8(b1) Measure skipping means not installing, in order of decreasing SIR or Priority List order, cost justified ECMs and related incidental repairs. In no case shall measures with higher Measure SIRs or measures higher in Priority List order be skipped unless the measure is unfeasible, as defined by the CSD TRM.

4.8.8(c) Client refusal of any measure must be documented in the dwelling work scope on the CSD 540 Form and noted on the CSD 710 Form.

4.8.8(d) Path-specific client refusal and measure skipping policies are defined in Client Refusal and Measure Skipping of PL Measures and Client Refusal and Measure Skipping of ADMs.

4.8.9 Client Education

4.8.9(a) Client education is important to inform a client of planned measures and material use.

4.8.9(b) Client refusal of any measures and/or materials included in a work scope must be addressed with additional measure education to determine the source of the client's concern(s) and an attempt to address the concern.

4.8.9(b1) If a client is resistant to an ECM because of the type of materials that would be used, and prefers installation with an alternate material (for example, energy efficiency upgrade of the dwelling's windows, but with wood frame rather than vinyl-framed windows), the alternate material must comply with 10 CFR 440, Appendix A and cost-effectiveness criteria.

4.8.9(b2) If the client continues to resist the ECM, and no cost-effective option can be identified, the auditor must identify if refusal would cause the dwelling to be deferred. It also may be necessary to discuss the situation with the building owner if the dwelling is tenant-occupied.

4.8.9(b3) If the building owner or occupant still declines a measure, the situation must be fully documented in the client file and Client Refusal and Measure Skipping of PL Measures and Client Refusal and Measure Skipping of ADMs must be followed.

4.8.10 Air Sealing (Infiltration-Reduction Activities)

4.8.10(a) Blower door testing and feasible air sealing activities (see Table D-2) are mandatory for every dwelling weatherized in the DOE WAP or the dwelling must be deferred. Client refusal of the diagnostic test also requires deferral.

4.8.10(b) Infiltration-reduction activities must be installed following the priority order of activities on the CSD 704 Shell Leakage Data Sheet and Appendix C Shell Leakage Test Protocol.

TABLE D-2: EXAMPLES OF AIR SEALING ACTIVITIES

Air Sealing
Caulking
Cover plate gaskets
Glass replacement
Minor envelope repair
Vent covers (interior)
Weatherstripping - door
Weatherstripping - other (i.e., access covers, enclosure doors, windows, etc.

4.8.11 The replacement of doors, sliding glass doors and windows for catastrophic leakage (as defined by the Appendix C Shell Leakage Testing Protocol and Section 32 Infiltration Reduction) is not allowed with DOE WAP funding. These replacements may be performed only when cost-justified by energy audit as an energy efficiency upgrade or as an incidental repair under certain conditions. Agencies are encouraged to use alternative funds for these items when catastrophic leakage is present.

4.8.12 Duct Repair and Sealing Activities

4.8.12(a) Duct leakage testing and feasible sealing and repair of the duct system is mandatory for every dwelling with ductwork in the DOE WAP. If the testing is unfeasible or the client refuses testing, the dwelling must be deferred.

4.8.12(b) Duct repair and sealing activities must be installed following the priority order of activities on the CSD 706 Duct Leakage Data Sheet and Appendix B Duct Leakage Test Protocol.

4.8.13 Restrictions for Door/Window Repairs and Replacements, & Roof Repairs

4.8.13(a) Installation of doors, sliding glass doors (SGD), window repairs and replacements, and for roof repairs, to resolve catastrophic leakage in the DOE WAP is not allowed.

4.8.13(a1) Agencies are encouraged to use alternative funds for these items when catastrophic leakage is the sole rationale for repair or replacement.

4.8.13(b) For the PL path, these measures must not be installed unless explicitly allowed.

4.8.13(c) For the Audit path, these measures must be included in the energy audit as defined in Audit Path Decisions for ADMs.

4.8.14 Minor Roof Repairs and Window, Door, or Sliding Glass Door (SGD) Repairs

4.8.14(a) Window, door, or SGD repairs may never be completed within the air sealing measure category.

4.8.14(b) In the DOE WAP, minor repairs may be completed if it meets all of the requirements for:

4.8.14(b1) Incidental Repair. These minor repairs must be made only to protect, preserve, or to allow installation of one or more measures. To be in this category, the incidental repair must be documented with photos and a written justification to define why the repair is necessary and what measure is being protected.

4.8.14(b2) The incidental repair cost maximum must be tracked separately, and it is cost-limited by the PL or audit.

4.8.15 Window, Door, or SGD Replacements

4.8.15(a) Window, door, or SGD replacements may never be completed within the air sealing measure category. Instead, replacements may only be completed as part of the following scenarios:

4.8.15(a1) Cost-Justified ECM. Windows or SGDs proposed to be replaced first must be explicitly included in the PL or cost-justified in an energy audit. Exterior doors do not qualify as an energy efficiency upgrade.

4.8.15(a2) Incidental Repair. Window, door, or SGD replacements may be considered as an incidental repair to preserve the integrity of an associated ECM. An example of this type of replacement is to prevent excess exfiltration when a heating or cooling unit is being installed. To be in this category, the incidental repair must:

- Be completed to protect or preserve a measure being installed, and
- Have photos and written justification to demonstrate why the repair is necessary and what measure is being protected
- Cost maximum is limited by the PL or audit. The associated cost must be tracked separately as an Incidental Repair line item.

4.9. Required Forms

4.9.1 CSD requires that the following forms be used for the identification of ADM and PL measures. The latest published versions of the forms must be used and are posted to the CSD Local Agencies Portal. Instructions are provided with each of the forms below. No contractor-equivalent forms will be allowed.

4.9.1(a) **CSD 544 Single-Family/Small Multi-Family Audit Input Report:** The CSD 544 mirrors the REM/Design data collection software inputs to ensure all data is collected while present during the on-site visit. This form applies to the DOE WAP and to LIHEAP when an audit will be conducted.

4.9.1(b) **CSD 710 DOE Energy Audit and Priority List Checklist (DOE WAP only):** The CSD 710 form is used to verify and document the decision-making process relative to use of the Audit and PL paths.

4.9.1(c) **CSD 808 REM/Design Multi-Family Input Sheet:** The CSD 808 is used to allocate unit-level data when small multi-family projects are completed. Since an Improvement Analysis Report (IAR) is generated by REM/Design to reflect the entire building, all units need to be tracked and costs allocated using this form and include the appropriate information allocated by unit.

4.9.1(d) **CSD 696 Multi-Family TREAT Energy Audit Bid Request Form**: The CSD 696 form is an aid for agencies in the solicitation of TREAT audit consultants.

4.9.1(e) **CSD 871 Pre-Weatherization Scope of Work (SOW)/Sources & Uses (S&U) Tool**: For TREAT audits, the CSD 871 spreadsheet is completed prior to the initial technical review to identify the proposed measure energy savings, measure cost, EUL, and SIR.

4.9.1(f) **CSD 872 Post-Weatherization Scope of Work (SOW)/Sources & Uses (S&U) Tool**: For TREAT audits, the CSD 872 spreadsheet is completed following the measure installation to confirm the final measure costs, SIR, EUL, etc.

4.9.2 It is the responsibility of the agencies to update to the latest version of forms as soon as they are released, but no later than by the implementation date set by CSD. It is also the agency's responsibility to distribute these documents to field staff and subcontractors within required timeframes.

5. MANAGING ALTERNATIVE FUNDING

5.1 CSD Weatherization programs may use a combination of federal and non-federal funds to complete the work scope.

5.1.1 Federal funds include, but are not limited to:

5.1.1(a) DOE WAP funds

5.1.1(b) DOE WAP competitive funds (e.g., SERC, E&I, etc.)

5.1.1(c) Low Income Home Energy Assistance Program (LIHEAP) funds

5.1.1(d) Community Development Block Grant Program (CDBG)

5.1.2 Non-federal funds include, but are not limited to:

5.1.2(a) Utility investments from systems benefit charges or efficiency programs

5.1.2(b) State funds from special set-asides

5.1.2(c) Other rehabilitation funds

5.1.2(d) Private funds from landlord contributions or foundations

5.1.2(e) Other private sources

5.2. Measure Leveraging

5.2.1 There are two ways leveraged funds are handled within the DOE WAP – braiding funds, and co-funding.

5.2.2 DOE policies and protocols shall prevail for measures installed using DOE WAP funding. If the unit is leveraged with LIHEAP, policies and procedures apply to installation of the leveraged measure(s). Leveraging may be applied to all housing types.

5.2.3 Measures that do not meet the SIR requirements for cost effectiveness, can be leveraged with another funding source as long as the measure meets the feasibility criteria for the program in which the measure is being leveraged.

5.2.4 Full Measure Leveraging (Braiding Funds)

5.2.4(a) Full measure leveraging or braiding of funds is when the entire measure cost will be paid for by the funds of any non-DOE program.

5.2.4(b) Full measure leveraging can be applied to measures of any category.

5.2.4(c) When an ADM will be fully leveraged the energy audit must include the installed condition as the "as-is" or base case before the energy audit is finalized. This policy is detailed in Interactive Effects for Energy Audits.

5.2.4(d) When a PL measure will be fully leveraged, even though it will be funded by a different program, DOE WAP measure policies will apply.

5.2.5 Partial Measure Leveraging (Co-funding)

5.2.5(a) Partial measure leveraging or co-funding is where the cost of a measure is divided between the DOE WAP and an alternative funding source.

5.2.5(b) Partial measure leveraging is only allowed for ADMs.

5.2.5(c) Measures must have a Measure SIR < 1.0, but ≥ 0.5, to qualify for partial measure leveraging. The amount billed under both DOE and the alternative funding source cannot exceed the total cost of the installation for the measure.

5.2.5(d) When DOE WAP funds are used for partial measure leveraging, the following conditions must be met:

5.2.5(d1) Where DOE WAP funds are used to co-fund a measure, the amount of DOE funds must result in a Measure SIR of 1.0.

5.2.5(d2) Partial measure leveraging must be applied to measures from highest to lowest Measure SIR. For example, partial measure leveraging must be applied to a measure with an SIR of 0.8 before a measure with an SIR of 0.5.

5.2.5(d3) The use of partial measure leveraging cannot change the installation order of measures based on the full measure costs. If partial measure leveraging results in a change of installation order, the measure with an SIR ≥ 1.0 prior to the partial measure leveraging must be installed.

5.2.5(d4) The package of measures, limited to the DOE investment, must have a Dwelling SIR ≥ 1.0. Measures that are not included in this package do not qualify for partial measure leveraging.

5.3. Cost Sharing

5.3.1 Cost sharing is not leveraging. It applies only to Health & Safety, PL, and General Heat Waste measures. This billing option shall not be used for ADMs.

5.3.1(a) This option provides flexibility to agencies to meet: (1) the average cost per unit (ACPU), or (2) the maximum average reimbursement per unit (known as Contractor ACPU at the agency level), or (3) maximum Health and Safety expenditures.

5.3.2 When cost sharing, all labor must be billed to DOE WAP. Material costs may be billed entirely to another program or shared between the DOE WAP and another program.

5.3.3 Total cost sharing amounts for a measure cannot exceed the actual cost and the maximum measure rate established by contract.

5.4. Measure Buy-down

5.4.1 The multi-unit building buy-down creates flexibility in buildings where the property owner/landlord contributes to the cost of a measure as a "buy-down".

5.4.1(a) Owners/landlords of single-family (2-4 unit buildings only), small multi-family, or large multi-family rental properties may contribute funds or rebates.

5.4.1(b) Measure buy-down is optional.

5.4.2 Buy-downs apply to all units, except the dwelling unit(s) occupied by the owner/landlord.

5.4.3 When a measure buy-down occurs, the following criteria must be met:

5.4.3(a) The Measure SIR shall be ≥1.0, using the reduced measure cost (i.e., DOE WAP portion) within the energy audit.

5.4.3(b) The Dwelling SIR must be ≥1.0, using the total installed cost of the measures (reduced cost + owner/landlord contribution) of all measures to be installed in the dwelling.

5.4.4 Buy-down measures may not be installed before other measures in the work scope.

5.4.5 Owners/landlords may only buy-down measures with a Measure SIR <1.0.

5.4.6 Buy-downs cannot be used to change the order of installation. They may only be installed after all other cost-effective measures not requiring buy-down have been installed.

6. PRIORITY LIST PATH METHODOLOGY

6.1 Rather than perform a site-specific energy audit, the PL path allows for a defined list of measures to be installed. The PL can only be used when DOE WAP funds will be used.

6.1.1 The PL path may be used when ALL of the dwelling criteria for a specific dwelling type are met:

6.1.1(a) To use the PL path, the answer must be YES to all statements for that dwelling type and the "Applies to All Building Types" section. If the answer is NO to any of the statements, the Audit path is required.

6.1.1(a1) Single-Family

- The home is a single-family residence.
- The home is 3-stories or less above grade.
- The home structure is wood-framed and site-built.
- The primary heating system is:
  - NOT a closed (sealed) combustion natural gas furnace originally rated for ≥90% AFUE.
  - NOT a heat pump manufactured after 2006.
- Incidental Repair costs paid for with DOE WAP funds will be less than $500.

6.1.1(a2) Mobile Home

- The home is a single-wide or double-wide manufactured home.
- The home was manufactured before 2010.
- The home has an accessible unconditioned subspace.
- The home does NOT have an attached conditioned addition.
- The primary heating system is NOT a natural gas furnace originally rated for ≥80% AFUE.
- Incidental Repair cost paid for with DOE WAP funds will be less than $500.

6.1.1(a3) Multi-Family

- The building is 3-stories or less above grade (low-rise).
- The building contains 5 or more dwelling units.
- The building structure is wood-framed.
- Incidental Repair cost paid for with DOE WAP funds will be less than 10% of the project's total ECM package.

6.1.1(b) Applies to All Building Types

6.1.1(b1) If included in the final work scope, any heating, cooling or water heating appliance repairs or replacements, and the associated thermostat (when applicable) will be paid for by another funding source (non-DOE WAP).

6.1.1(b2) No additional ECMs (other than those on the PL) will be included on the work scope to be billed to DOE WAP. See Audit Path Decisions for ADMs.

6.2 There are three different PLs, one for each building type listed below. Dwelling types that are not listed below are not eligible for Priority List measures.

6.2.1 Single-family: 1-4 dwelling units

6.2.2 Mobile homes: A permanent, full-time residence with a floor area of at least 330 feet.

6.2.3 Low-rise multi-family (LRMF): 5+ dwelling units per building, with no more than 3 stories above grade in height.

6.3. PL Path Measures

6.3.1 PL measures are divided into two categories: mandatory and optional measures.

6.3.1 (a) All feasible measures included in the mandatory category must be installed when DOE WAP funds are used for the job.

6.3.1 (b) Measures in the optional category may be installed in the dwelling with any funding source, including DOE WAP funds, if all other feasible mandatory measure are also installed.

6.3.2 A summary of the measures included in the PL path are detailed in Table D-3 along with the assigned measure category. The final PL will be determined for a dwelling based on the dwelling type and primary heating source fuel.

6.3.3 Priority list minimum specification tables for each building type are provided in Priority List Tables.

TABLE D-3: PRIORITY LIST MEASURES

Priority List Path - Measures	Single-Family	Mobile Home	Multi-Family
Health and Safety (defined in CSD 710)	M	M	M
LED bulbs	M	M	M
Air sealing	M	M	M
Duct sealing	M	M	M
Duct insulation	M	N/A	M
Window replacement	N/A	O[1]	N/A
Ceiling insulation	M	M	M
Wall insulation	M	N/A	M
Floor insulation	M[1]	N/A	N/A
Faucet aerators	O	O	O
Showerhead (low-flow, handheld, thermostatic)	O	O	O
Water heater blanket	O	O	O
Water heater pipe insulation	O	O	O
Refrigerator	O	O	O
LED fluorescent tube lighting	N/A	N/A	O
Cooling replacements	O[2]	O[2]	O[2]
Heating replacements	O[1,2]	N/A	O[1,2]

M – Mandatory Measure; O – Optional Measure; N/A – Not an allowable PL measure

[1]Dependent on primary heat fuel type

[2]Dependent on existing equipment type

6.4. Developing a PL Work Scope

6.4.1 Only ECMs listed on the PL may be installed when using the PL path.

6.4.1(a) The PL does not include every measure that may be cost effective for a specific dwelling.

6.4.1(a1) When any energy conservation measure(s) not included within the PL may be feasible, or if the dwelling does not meet the basic PL conditions, a site-specific audit is required.

6.4.2 Additional PL measure-specific feasibility and installation requirements are addressed in the DOE-Specific criteria sections of the TRM for each measure.

6.4.3 All required Health and Safety (H&S) measures must be installed in the dwelling.

6.4.3(a) H&S measures for the PL path are listed in Table D-4.

TABLE D-4: PRIORITY LIST PATH - H&S MEASURES

Priority List Path - Health & Safety Measures
Carbon monoxide alarms
Smoke alarms
Cooling source repairs and replacements[1]
Combustion and ventilation air repairs
Heating source repairs and replacements[1]
Kitchen exhaust installation, repair, and replacements
Lead-safe weatherization
Limited home repair-health and safety support
Mechanical ventilation
Thermostats (manual and programmable)[1]
Water heater repairs and replacements[1]
[1]All Health and Safety-related heating, cooling, water heating repairs and replacements (including an associated thermostat, when applicable), must be fully leveraged with an alternative funding source or a site-specific audit is required if billed to DOE WAP.

6.4.4 Water Measures

6.4.4(a) The measures in this group include faucet aerators, showerheads (low-flow, handheld and thermostatic), water heater blankets and water heater pipe insulation.

6.4.4(b) Total water measure costs (including labor) must not exceed $250 in total for all measures within this category.

6.4.5 Refrigerator replacements in the PL path must have a Measure SIR ≥ 1.0. using the CSD 540E Refrigerator Calculator to be installed.

6.4.6 Heating and Cooling Replacements

6.4.6(a) Heating and cooling replacements are limited to the primary system

6.4.6(b) Only the specific replacements listed on the CSD 710 for the PL are allowed.

6.4.6(b1) Energy efficiency upgrades to heating and cooling appliances other than those listed on the PL require a site-specific energy audit.

6.4.6(c) No fuel switching measures will be allowed using the PL path.

6.4.7 If no measures meet the Measure SIR or Dwelling SIR requirements based on the energy audit inputs, and the PL path dwelling conditions apply, the CSD 710 Energy Audit/Priority List Checklist will be updated and the PL path will be used to determine the final work scope.

6.5. PL Justification Images and Narrative

6.5.1 For measures on the PL that are unfeasible (e.g., cannot structurally be installed, do not meet measure feasibility criteria, etc.), it is required to document the existing dwelling conditions that prohibit installation.

6.5.1 (a) Photo of the affected location(s) is required.

6.5.1 (b) Using TRM feasibility criteria, a written justification shall be provided on the CSD 540 Dwelling Assessment form and the CSD 710 Energy Audit/Priority List Checklist.

6.5.1 (c) All required photographs in TRM Section 1 Required Photographs (Justification Images) also shall apply.

6.6. Incidental and Ancillary Costs in the PL Path

6.6.1 The DOE WAP requires the cost of all ECMs (and associated incidental repairs) to be tracked for priority list measures in accordance with the following requirements:

6.6.1 (a) Ancillary materials used must be included in the total cost of the PL measure. If the cost of the ancillary item added to the measure cost would exceed the defined measure maximum, then the PL measure is no longer feasible.

6.6.1 (b) Incidental repairs necessary for the installation of a PL measure shall be tracked separately from the installed measure cost, and the total incidental repair cost shall not exceed the maximum amount allowed by the PL path criteria as defined below:

6.6.1 (b1) For Single-Family Dwellings: The total cost of all Limited Home Repairs shall not exceed $500. This applies to detached homes and multi-unit buildings with 1–4 units.

6.6.1 (b2) For Mobile Homes: The total cost of all Limited Home Repairs shall not exceed $500.

6.6.1 (b3) For Low-Rise Multi-Family Buildings: The total cost of all Limited Home Repairs shall not exceed 10% of the project's total ECM package of measures (all units).

6.6.2 All incidental repairs must be documented with 1) cost justification for each incidental repair, and 2) photos and written explanation to justify the need for the incidental repair in the client file.

6.7. Populating the PL

6.7.1 Once the PL path decision has been made on the CSD 710 Energy Audit/Priority List Checklist, select the building type for the dwelling to be served (one of three available types) and the primary heat source fuel.

6.7.2 The PL measures will automatically fill into the form in the order of cost-effectiveness.

6.8. PL Installation Order

6.8.1 Measures on the final work scope must be installed in the order of measures defined by the CSD 710 form.

6.8.2 All mandatory PL measures must be installed prior to optional PL measures.

6.9. Client Refusal and Measure Skipping of PL Measures

6.9.1 If a client refuses a measure, client education must be provided in accordance with Client Education and Table D-5.

TABLE D-5: PL PATH – MEASURE SKIPPING POLICIES

Circumstance	CSD Policy
Before work begins, client refuses a feasible **Mandatory** measure	• Client education about planned measures and materials shall be provided. • If a client refuses a Mandatory measure and an alternate material is acceptable to the client and does not exceed the measure maximum, the alternate material may be used. • If the client continues to refuse the Mandatory measure, the refusal must be documented in the CSD 540 and CSD 710 and the dwelling must be deferred.
After installation work has begun, client refuses a feasible **Mandatory** measure	• If a client refuses a higher priority Mandatory measure after lower priority measures are already installed (due to timing of the physical installation work): – Work must stop at the time the client declines the higher priority measure. – No further measure installations are allowed. – The job must be inspected by a QCI and closed out as a completed unit. • Further work may be done under a different program.
Before or after work begins, client refuses a feasible **Optional** measure	• If a client refuses an Optional measure, client education about planned measures and materials shall be provided. • If an alternate material is acceptable to the client and does not exceed the measure maximum, the alternate material may be used. • If no cost-effective option can be identified and/or the client still refuses the measure, the client refusal must be documented in the client file on the CSD 540 and CSD 710, then all other cost-effective measures may be installed.

6.10. PL Measure Cost Maximums

6.10.1 The billed measure cost must not exceed the contract maximum reimbursement for any measure on the PL or the measure is unfeasible. A CSD waiver will not be approved.

6.11. PL Quality Assurance Review

6.11.1 During its monitoring of agencies, CSD will review PLs applied by the assessor/auditor to ensure that:

6.11.1 (a) Audit/PL path decision was correctly made, and

6.11.1 (b) All cost-effective ECMs were installed.

7. AUDIT PATH METHODOLOGY

7.1 Energy audits identify the cost-effectiveness of feasible ADMs for the dwelling work scope. Auditors/assessors must conduct a standard assessment to identify all feasible measures allowed by CSD.

7.1.1 The Audit path must be used when:

7.1.1 (a) Any one or more of the PL dwelling criteria cannot be met.

7.1.1 (b) Heating, cooling, or water heating appliance repairs or replacements (not on the PL) and an associated thermostat, when applicable, will be billed to DOE WAP.

7.1.1 (c) ECMs included in the proposed work scope are not on the PL, and will be billed to DOE WAP.

7.2 The required audit tool depends on the dwelling type and number of units defined in Table D-6. Small multi-family buildings also consider whether heating and/or cooling systems are independent or common systems.

TABLE D-6: ALLOWABLE AUDIT TOOL BASED ON BUILDING TYPE

Building Type	ECM Evaluation Tools	
	REM/Design	TREAT
Single-family, 1-4 units	X	
Manufactured Housing, individual unit	X	
Small Multi-family Building, 5-24 units with independent heating and/or cooling units, and a storage water heater (independent or common system)	X	
Small Multi-family Building, 5-24 units with common (shared) heating and/or cooling systems, or common water heating utilizing a non-storage system (i.e., boiler)		X
Large Multi-family, 25 units or more		X

7.3. Audit Path Measures

7.3.1 There are three measure categories included as part of the Audit path: Health & Safety, General Heat Waste, and ADMs.

7.3.1 (a) Audit Path Health & Safety (H&S) Measures

7.3.1 (a1) All required H&S measures must be installed and do not require a Measure SIR ≥1.0.

7.3.1 (a2) Table D-7 defines H&S measures that must be included in the Audit path.

TABLE D-7: AUDIT PATH - H&S MEASURES

Audit Path - Health & Safety Measures
Carbon monoxide alarms
Smoke alarms
Cooling source repairs and replacements
Combustion and ventilation air repairs
Heating source repairs and replacements
Kitchen exhaust installation, repair, and replacements
Lead-safe weatherization
Limited home repair-health and safety support
Mechanical ventilation
Thermostats (manual and programmable)
Water heater repairs and replacements

7.3.1 (b) H&S Fund Limitations for Audits

7.3.1 (b1) When paid for with DOE WAP funds, a heating, cooling, and/or water heating repair or replacement, or thermostat measure can qualify either as H&S or as an ECM (i.e., an energy efficiency upgrade).

- All heating, cooling and water heating replacements, and the associated thermostat (when applicable), must be modeled in the audit to determine if an energy efficiency upgrade is feasible prior to billing DOE WAP H&S.
  - When replacement with a more efficient appliance has a Measure SIR ≥ 1.0 calculated by the energy audit, replacement as an ECM is required. The cost maximum is determined by the energy audit.
  - H&S repair or replacements will be considered only after an energy efficiency upgrade would not be cost-effective (Measure SIR is <1.0). The cost maximum is determined by contract.
    - When an audit is performed it must include a cost benefit analysis to determine the optimal appliance type. If replacement is necessary for the safety of occupants, an open combustion appliance should be replaced with a closed combustion or direct vent type.
    - The primary heating appliance may be replaced, repaired, or installed when the appliance has been “red-tagged,” is inoperable, or is nonexistent.
    - The primary air conditioning system may be replaced, repaired, or installed only in homes where an occupant is “at-risk”.
      - CSD defines an “at-risk” occupant as a client with a qualifying “medical condition” that requires temperature control. The condition must be verified by a doctor’s recommendation or other objective evidence gathered at the time of application.
      - The occupant is a member of a vulnerable population, and the absence of the appliance creates an emergency health and safety need.
    - When a water heating replacement does not qualify for an ECM replacement, the system may be repaired or replaced using H&S funds if repair/replacement requirements are met.

7.3.1 (c) General Heat Waste (GHW) Measures

7.3.1 (c1) GHW can only be installed using the Audit path. GHW costs (including labor) must not exceed $250 in total for all measures in this category.

7.3.1 (c2) Table D-8 includes GHW measures included in the Audit path.

TABLE D-8: AUDIT PATH - GENERAL HEAT WASTE MEASURES

Audit Path - GHW Measures
Air filters (heating and/or cooling)
Faucet aerators
Showerheads (low-flow, handheld, thermostatic)
Water heater pipe insulation
Water heater blanket

7.3.1 (d) Audit-Driven Measures (ADMs)

7.3.1 (d1) ADMs must be included in the audit. ADMs resulting in a Measure SIR ≥ 1.0 are to be included in the final work scope.

7.3.1 (d2) Table D-9 includes all ADMs included in the Audit path.

TABLE D-9: AUDIT PATH - AUDIT DRIVEN MEASURES

Audit Path - ADMs
Ceiling insulation (and attic ventilation, when required)
Ducting repair, sealing, and insulation
Energy efficiency upgrade – cooling source replacement
Energy efficiency upgrade – heat source replacement
Energy efficiency upgrade – programmable thermostat
Energy efficiency upgrade – smart thermostat
Energy efficiency upgrade – water heater replacement
Energy efficiency upgrade – window replacement
Floor insulation (and floor foundation venting, when required)
Air sealing (infiltration reduction)
LED lighting (bulbs and tube lighting)
Refrigerators
Wall insulation

7.4. Audit Path Decisions for ADMs

7.4.1 When the auditor determines that an ADMs is not on the PL and the ADM would be billed to the DOE WAP, the auditor must follow this procedure.

7.4.1 (a) If one or more of the measures in Table D-10 is feasible according to the measure-specific feasibility criteria in the TRM, and criteria described below also applies, a site-specific energy audit is required.

7.4.1 (b) For reference, the Effective Useful Life for heating, cooling, and water heating equipment is included in Effective Useful Life (EUL) Inputs.

TABLE D-10: INSTALLATION CRITERIA FOR ADMS NOT ON A PRIORITY LIST

ADMs Not on the Priority Lists	An Audit Will Be Required When...
Energy efficiency upgrade – cooling source replacement	The existing cooling source is past its EUL.
Energy efficiency upgrade – heat source replacement	The existing heating source is past its EUL.
Energy efficiency upgrade – programmable thermostat	A manual thermostat is present.[1]
Energy efficiency upgrade – smart thermostat	A manual thermostat is present.[1]
Energy efficiency upgrade – water heater replacement	The existing water heater is past its EUL.
Energy efficiency upgrade – window replacement	One or more single-paned windows are present.
Floor insulation (includes floor foundation venting, when required)	No existing floor insulation is present.
Wall insulation	No existing wall insulation is present.
[1]The auditor must assess feasibility for a smart thermostat. If material costs cause the Measure SIR to be < 1.0, then a programmable thermostat shall be considered.	

7.5. Client Refusal and Measure Skipping of ADMs

7.5.1 "Major measures" shall not be skipped. For the Audit path, measure skipping policies for the Audit path are outlined in Table D-11. Major measures are defined as:

7.5.1 (a) Air sealing (infiltration-reduction)

7.5.1 (b) Sealing of ducts (located outside the thermal boundary)

7.5.1 (c) Attic insulation

7.5.1 (d) Wall insulation

7.5.1 (e) Floor insulation (conventional homes) or belly insulation (mobile homes)

Table D-11: Audit Path – Measure Skipping Policies

Circumstance	CSD Policy
Before work begins, client refuses a feasible **Major** measure	• Client education about planned measures and materials shall be provided. • If a client refuses a major measure and an alternate material that is acceptable to the client is identified, an audit will be re-run to recalculate the SIR. • If the client continues to refuse the major measure, the refusal must be documented in the CSD 540 and CSD 710 and the dwelling must be deferred.
After installation work has begun, client refuses a feasible **Major** measure	• If a client refuses a higher priority major measure after lower priority measures are already installed (due to timing of the physical installation work): – Work must stop at the time the client declines the higher-SIR measure. – No further measure installations are allowed. – The job must be inspected by a QCI and closed out as a completed unit. • Further work may be done under a different program.
Work must stop at the time the client declines the higher-SIR measure.	• If a client refuses a non-major measure or material that has SIR ≥1.0, client education about planned measures and materials shall be provided. • If the client refuses and there is a cost-effective alternative the audit must be re-run with materials that are acceptable to the client. • If no cost-effective option can be identified and/or the client still refuses the measure, the client refusal must be documented in the client file on the CSD 540 and CSD 710, then all other cost-effective measures may be installed.

7.6. Developing an Audit Work Scope

7.6.1 For the Audit path, auditors/assessors must include all proposed/feasible ADMs (and incidental repairs) in the audit software to create a preliminary work scope.

7.6.2 Measure SIRs will be calculated by the energy audit tool.

7.6.2 (a) When calculating the Measure SIR, all interactive effects of other measures in the package specified by the energy audit must be accounted for.

7.6.2 (a1) To be included in the work scope, all measures must have a Measure SIR ≥ 1.0.

7.6.2 (a2) Exception: Air sealing is the only measure allowed to be installed when the Measure SIR < 1.0, however the Dwelling SIR must be ≥ 1.0.

7.6.2 (b) After the first audit run, if the Dwelling SIR is <1.0, it is required to remove the ADM (and its associated incidental repair) with the lowest SIR.

7.6.2 (b1) Exception: Per DOE WAP policy, do not remove air sealing when the Measure SIR < 1.0.

7.6.3 Using the audit tool, all final ADM Measure SIRs and any incidental repair costs must be "grouped". This grouped SIR becomes the "Dwelling SIR"

7.6.3(a) The Dwelling SIR must be ≥1.0 or individual measures are not feasible.

7.6.3(a1) If the Dwelling SIR <1.0, remove the lowest ECM and its associated incidental repair) from the work scope, then re-group the measures to check the new Dwelling SIR. Continue this process until the Dwelling SIR achieves a final SIR of ≥1.0.

7.6.3(a2) The Dwelling SIR must be ≥1.0 or the job must be deferred.

7.6.3(a3) The final Dwelling SIR value must be transferred from the audit to the CSD 710.

7.6.3(a4) The finalized work scope must show the ranking of all ADMs from highest to lowest SIR to guide the installation order.

7.6.4 If no measures meet the Measure SIR or Dwelling SIR requirements based on the energy audit inputs, and the PL path dwelling conditions apply, the CSD 710 Energy Audit/Priority List Checklist will be updated and the PL path will be allowed to determine the final work scope.

7.7. ADM Cost Calculations

7.7.1 For all ADMs, the installed cost of a measure entered into the audit should reflect the actual cost to install the measure as closely as possible. In cases where the cost to install a measure changes after approval of the finalized work scope, an updated cost shall be input into the audit, and the measure will be reimbursed as follows:

7.7.1(a) If the updated cost is less than the original estimated cost, CSD will reimburse for the actual cost of the measure.

7.7.1(b) If the updated cost is greater than the reported cost, CSD will reimburse for the reported cost of the measure based on the following:

7.7.1(b1) The full measure cost may be reimbursed if an updated SIR calculation shows that the Measure SIR and Dwelling SIR remain ≥1.0 based on the updated cost.

7.7.1(b2) If the increased cost reduces the Measure or Dwelling SIR < 1.0, the measure shall be reimbursed only up to the cost where the SIR remains ≥ 1.0. No additional cost will be paid for that measure with DOE WAP funds.

7.8. Interactive Effects for Energy Audits

7.8.1 The interactive effect between measures is the way in which the installation of one measure will affect other measures in the work scope.

7.8.1(a) When calculating both the Measure SIR and Dwelling SIR, the audit must account for all ECMs included in the dwelling's work scope regardless of the program/funding source. It is not allowed to conduct separate audits by program.

7.8.1(a1) When a Measure SIR is < 1.0 and will be paid for by a different funding source, it must be updated in the base case of the energy audit before the work scope Measure SIRs and the Dwelling SIR are calculated.

7.8.1(a2) When a Measure SIR is ≥ 1.0 and will be installed under another program, the ECM will remain in the package of improvement measures and the base case would not be updated.

7.8.1(a3) When evaluating a heating, cooling, or water heating measure as an energy efficiency upgrade, and the resulting Measure SIR is < 1.0 and the appliance has an identified H&S issue, the ECM may be recategorized as a H&S measure. When this occurs, the energy audit must be re-run based on actual equipment that will be installed included as the base case before the energy audit is finalized.

7.9. Justification Image Requirements for REM/Design Energy Audits

7.9.1 Justification images (photos) are required that show the key characteristics of the audited dwelling. Photos submitted are used for quality assurance and aid in answering questions that arise during the audit review.

7.9.1 (a) The following photos must be kept on file for any REM/Design audited dwelling:

7.9.1 (a1) *Front View of Dwelling:* View of all walls, windows, and any shading, including but not limited to, trees, other buildings, etc.

7.9.1 (a2) *Back View of Dwelling:* View of all walls, windows, and any shading, including but not limited to, trees, other buildings, etc.

7.9.1 (a3) *Right Side View of Dwelling:* View of all walls, windows, and any shading, including but not limited to, trees, other buildings, etc.

7.9.1 (a4) *Left Side View of Dwelling:* View of all walls, windows, and any shading, including but not limited to, trees, other buildings, etc.

7.9.1 (a5) *Close-up of Each Window Type:* Close-ups to determine window type, one picture required for each type.

7.9.1 (a6) *Whole Attic View:* Show as much attic space as possible.

7.9.1 (a7) *View of Attic Insulation:* Up-close view of attic insulation showing a measuring tool confirming thickness of insulation or a visible R-value.

7.9.1 (a8) *View of Floor Insulation:* Up-close view of crawlspace showing a measuring tool confirming thickness of existing insulation or a visible R-value.

7.9.1 (a9) *Primary Heating Source:* Include nameplate if possible, must photograph the primary heating source for all units in a multi-family dwelling and associated thermostats.

7.9.1 (a10) *Primary Cooling Source:* Include condenser coil and nameplate if possible, must photograph the primary cooling source for all units in a multi-family dwelling and associated thermostats.

7.9.1 (a11) *Primary Water Heating Source:* Include a view of the full tank and associated platform when present. Close up view of nameplate.

7.9.1 (a12) *Other:* Any unusual circumstance of the dwelling which may cause question.

7.9.1 (b) CSD may request justification image copies or additional images at any time.

7.9.2 For TREAT energy audits, required photographs are identified in TREAT Energy Audit Report Requirements, and are mandatory when applicable to a specific project.

7.10. Incidental and Ancillary Costs in the Audit Path

7.10.1 In the DOE WAP, ancillary materials used must be included in the cost of an ADM measure. If the cost of the ancillary item added to the measure cost would cause the SIR to be <1.0 then the measure is no longer feasible.

7.10.2 For ADMs, costs of all incidental repairs must be “grouped” in a separate line item within the audit and included in the calculation of the Dwelling SIR.

7.10.2 (a) All incidental repairs must be documented with 1) cost justification for each incidental repair, and 2) photos and written explanation to justify the need for the incidental repair in the client file.

7.10.2 (b) After the first audit run, if the Dwelling SIR <1.0, it is required to remove the combination of the ECM and its associated incidental repair with the lowest SIR. This process (removing the lowest ECM and its associated incidental repair) continues until the Dwelling SIR is ≥1.0.

7.10.2 (c) If an incidental repair is necessary to protect more than one ADM, (e.g., roof repair to protect attic insulation and a heating system upgrade located in the attic), then all of those ECMs together must be considered for removal from the package of measures until the SIR for the package of measures is ≥1.0.

7.10.2 (c1) Removal of measures and incidental repairs could result in temporary deferral of a dwelling until another funding source is found to pay for the incidental repair(s).

7.11. Additional Audit Path Considerations

7.11.1 Air Sealing in the Audit

7.11.1(a) The total cost for all air sealing activities must be included in the energy audit and an infiltration/reduction line item must be included in the calculation for the Dwelling SIR.

7.11.1(b) To be feasible, the Dwelling SIR (including all infiltration reduction activities) must remain ≥1.0.

7.11.1(c) If feasible air sealing activities exist but do not meet the Dwelling SIR requirement, or an audit is not required because all ADMs are already installed, agencies may use alternative funds for this work (when available).

7.11.1(d) When this measure will be leveraged, the measure must be modeled as described in Shell Leakage Modeling.

7.11.2 Duct Repair and Sealing in the Audit

7.11.2(a) The Measure SIR for all duct sealing/repair work must be calculated separately from the infiltration-reduction measures in the DOE WAP.

7.11.2(b) The costs for all duct sealing, repair, and insulation activities shall be grouped together to calculate the Measure SIR for this item. This Measure SIR must be included in the calculation of the Dwelling SIR as a separate line item.

7.11.2(c) Both the Measure SIR and the Dwelling SIR require an SIR ≥1.0 to be a feasible DOE WAP measure.

7.11.2(d) When this measure will be leveraged, the measure must be modeled as described in Duct System Leakage Modeling.

7.11.3 Measure Grouping for Window Replacements

7.11.3(a) For window replacements to be considered cost effective, the windows must have a Measure SIR ≥1.0. In order to accurately characterize all window replacements, the upgrade must be considered in a “group” or “package”.

7.11.3(b) Whenever windows are included in the energy audit, the individual characteristics shall be included in the as-is model, then grouped by measure type during the improvement analysis using the process defined by the audit software.

7.11.3(b1) The measure may be subdivided and grouped by “type”, such as all aluminum frame windows would be included in Group 1, all wood frame windows included in Group 2, etc.

7.11.4 HVAC Component Modeling

7.11.4(a) Within the energy audit, HVAC system components are modeled in two ways (See Table D-12).

TABLE D-12: HVAC MODELING TYPES FOR ENERGY AUDITS

Separate Heating & Cooling Models	Single Heating & Cooling Models
Split System	Heat Pump
Package Unit	
Mini-Split Unit	

7.11.4(a1) When separate heating and cooling components are modeled (i.e., for split systems, package units, and mini-split units), heating and cooling will each have a separate, calculated Measure SIR.

- If the Grouped SIR ≥1.0, then both components shall qualify and be replaced by the higher efficiency units.

- If the Grouped SIR <1.0, then:
  - If only the heating component has an SIR ≥1.0, the heating unit shall be billed as an ECM. If the SIR is <1.0 and there is a qualifying H&S issue, the heating unit can be billed to DOE WAP H&S or leveraged with LIHEAP or another funding source.
  - If only the cooling component has an SIR ≥1.0, the cooling unit shall be billed as an ECM. If the SIR is <1.0, the following question shall be considered:
    - Is the client "at-risk"? CSD defines an "at-risk" occupant as a client with a qualifying "medical condition" that requires temperature control. The condition must be verified by a doctor's recommendation or other objective evidence gathered at the time of application.
      - If the answer is "yes", the cooling unit can be billed to DOE WAP Health & Safety or leveraged with LIHEAP or another funding source.
      - If the answer is "no", the cooling unit will not qualify as a DOE WAP Health & Safety measure but can be leveraged with LIHEAP or another funding source to allow for installation. If other leveraged funding is not available, the measure will not be installed.

7.11.4(a2) When both heating and cooling components are modeled as a single unit (i.e., heat pumps), the audit will result in a single SIR value.

- If the SIR is ≥1.0, the unit will be replaced as an energy efficiency upgrade.
- If the SIR is <1.0 and there is a qualifying H&S issue, the unit can be repaired or replaced as a DOE WAP H&S measure or leveraged under another funding source.

7.11.5 Derating Heating and Cooling Systems

7.11.5(a) Air conditioners and heat pumps cannot accurately be measured for efficiency while on-site. When evaluating a system that utilizes a compressed refrigerant cycle (does not apply to evaporative coolers), Equation 3 may be used in the audit.

Equation 3: Derated Efficiency = (Base EFF) x $0.99^{\text{appliance age}}$

Where:

Base EFF = Typical efficiency of Pre-Retrofit equipment when new (Seasonal Energy Efficiency Ratio (SEER), Energy Efficiency Ratio (EER), or Heating Seasonal Performance Factor (HSPF))

Appliance Age = Age of equipment in years.

7.11.5(b) *For example: An existing HVAC unit that is 20 years old, was originally rated at 10 SEER.*

Derated SEER = 10 x $0.99^{20\text{ years}}$

Derated SEER = 10 x 0.818

Derated SEER = 8.18

7.11.5(c) Any other variation of this process or formula is not allowed. Derating of combustion appliances in lieu of testing for combustion efficiency is not allowed.

7.11.6 Fuel Switching

7.11.6(a) Fuel switching will be allowed only within the Audit path with a site-specific energy audit that demonstrates the cost-effectiveness of the fuel switch over the life of the measure with a Measure SIR ≥ 1.0.

7.11.6(b) Table D-13 lists examples of possible fuel switching scenarios.

7.11.6(c) The energy audit model must include all energy costs associated with both the existing and proposed appliances.

7.11.6(c1) For example, when modeling a heat pump or other combined heating-and-cooling system to replace a heating-only (or cooling-only) system, no savings may be attributed to the previously non-existent cooling (or heating) system.

7.11.6(d) All upgrades to the home associated with the fuel switching must be included in the fuel-switching model to ensure the energy savings is based on post-weatherization home specifications.

7.11.6(e) Fuel cost information must be the actual cost as incurred by the client. Each household must produce a copy of a current fuel bill including a list of charges including: the costs charged for the energy commodity, base and service charges, taxes, supply and transmission charges and renewable energy or energy conservation adjustments. These components are all part of standard utility bills in the state of California.

7.11.6(e1) No additional non-energy impacts can be added to the fuel costs.

TABLE D-13: DOE WAP APPROVED FUEL SWITCHING SCENARIOS FOR ENERGY EFFICIENCY UPGRADES

Existing Heating or Cooling Appliance	Proposed Conversion
Electric wall furnace	Wall furnace, natural gas or propane
Electric forced air furnace (heating only)	Forced air furnace (heating only), natural gas or propane
Natural gas forced air furnace (heating only) or Natural gas split system (heating and cooling)	Central heat pump (heating and cooling)
Natural gas wall furnace or Natural gas wall furnace + window/wall AC	Ductless heat pump mini-split
Propane forced air furnace (heating only) or Propane split system (heating and cooling)	Central heat pump (heating and cooling)
Propane wall furnace or Propane wall furnace + window/wall AC	Ductless heat pump mini-split
Woodstove (heat only) or Wood stove + window/wall AC	Ductless heat pump mini-split
Water heater, natural gas or propane	Heat pump water heater

7.11.6(f) All costs related to fuel-switching, (i.e., permits and new or improved utility connections) must be included in the SIR calculation. The SIR calculation for fuel switching will follow the same calculation methodology as all other ECMs.

7.12. Audit Path Installation Order

7.12.1 Once the SIR order is calculated, scheduling of the actual order of the physical installation of measures may be adjusted. When a job is complete, measures with a higher SIR must have been installed over measures with a lower SIR unless an SIR-ordered measure is not feasible as defined by the TRM measure section.

7.12.2 Measures may be leveraged with another funding source if the measure meets all feasibility criteria for the leveraged program. See Managing Alternative Funding.

8. REM/DESIGN ENERGY AUDIT PROCEDURE

8.1 Applies to:

- Single-family dwellings
- Manufactured housing
- Small multi-family (with independent heating and/or cooling, and storage water heaters)

8.2 The three main processes that constitute the REM/Design energy audit include the:

8.2.1 On-site visit

8.2.2 Energy modeling with energy savings analysis, and

8.2.3 Report submittal

8.3. Energy Audit Restrictions

8.3.1 A REM/Design energy audit is part of the assessment and cannot be run after work has been installed to justify installation or recategorization of measures.

8.3.2 When an audit is conducted in multi-family buildings, the audit modeling must include the features of the whole building. Individual units with feasible ADMs must meet the criteria in Individual Units or only H&S and GHW measures may be feasible. Audit models may be used to justify measures for individual units located within a building complex.

8.4. REM/Design On-Site Visit

8.4.1 Energy audits must begin with a complete assessment of the building and building systems, including all environmental, structural, and health and safety checks. In addition, the energy audit collects additional data for energy calculations and an audit report is produced. The on-site visit by a qualified auditor/assessor is required to collect the data listed below.

8.4.2 Data listed below shall be recorded on the CSD 544 On-Site Data Collection Form, then entered into the REM/Design software:

8.4.2 (a) General Building Design Characteristics

8.4.2 (a1) Foundation type

8.4.2 (a2) Total conditioned area

8.4.2 (a3) Approximate conditioned area of each floor

8.4.2 (a4) Number of bedrooms

8.4.2 (a5) Ceiling height and ceiling/attic characteristics

8.4.2 (b) Building Envelope Characteristics

8.4.2 (b1) Ceiling type and insulation level

8.4.2 (b2) Above-grade wall type and insulation level

8.4.2 (b3) Foundation wall type and insulation level

8.4.2 (b4) Frame floor type and insulation level

8.4.2 (b5) Door type and insulation level

8.4.2 (c) Window Properties of All Windows

8.4.2 (c1) Window area for each glazing unit. Includes: sliding glass doors, glass block, etc.

8.4.2 (c2) Window type (single pane, dual pane low-E, etc.)

8.4.2 (c3) Window material (metal frame, wood, vinyl, metal clad etc.)

8.4.2 (c4) Window orientation (typically associated with each wall surface)

8.4.2 (c5) Window overhang (shading) details:

- Depth of overhang
- Distance between top of window and bottom of overhang
- Distance between bottom of window and bottom of overhang

8.4.2(d) Mechanical Equipment Properties

8.4.2(d1) Heating equipment

- Fuel type
- Location and type
- Rated output capacity (in Btu/hour)
- Seasonal equipment efficiency (AFUE, HSPF, %EFF, COP)

8.4.2(d2) Cooling equipment

- Fuel type
- Location and type
- Rated output capacity (in Btu/hour)
- Seasonal equipment efficiency (SEER, EER, %EFF, COP)

8.4.2(d3) Ventilation types (if applicable)

- Ventilation rate (CFM)
- Hours/day of operation
- Ventilation strategy for passive cooling (i.e., natural ventilation or whole house fan installed)

8.4.2(d4) Distribution systems for HVAC systems

- For ducted HVAC system (central HVAC) or ductless systems (i.e., evaporative cooler or mini-split system)
- Duct insulation level

8.4.2(d5) Water heating equipment

- Water heater type
- Fuel type
- Energy factor
- Tank size
- Extra tank insulation R-value

8.5. Energy Modeling and Analysis Process

8.5.1 Once data is collected, an energy model of the building's pre- and post-weatherization energy performance is generated in the REM/Design software. REM/Design calculates SIRs for each weatherization measure to determine its cost-effectiveness. For the calculations, some additional information is necessary and must be input by the auditor/assessor, including the EUL, measure cost, utility costs, building specifications, and default entries.

8.5.1(a) Measure cost calculations shall be handled in accordance with the policies of ADM Cost Calculations.

8.5.1(b) Measure buy-downs shall be addressed in accordance with Measure Buy-down.

8.5.1(c) EUL shall be calculated in accordance with REM/Design and Priority List Maximum EUL.

8.5.2 Mobile Home Modeling Specifications

8.5.2(a) When a mobile home will be served, the energy model must consider the special inputs related to mobile home construction. These inputs, which differ from a standard single-family home energy model, are detailed in Table D-14.

Table D-14: Mobile Home Modeling Specifications	
Parameter	**Requirement**
Housing Type	Mobile Home: The conditioned floor area input is disabled, instead input the outside length, width, and height
Ceiling and Floor Type	Input mode must be "Quick Fill Mobile Home"
Foundation Wall Type	Account for existing mobile home skirting

8.5.3 Multi-Family Whole-Building Modeling Specifications

8.5.3(a) In REM/Design, when an entire multi-family building is being served it must be modeled as one whole building with all units and mechanical components. The whole-building specifications outlined in Table D-15 must be input into the model.

Table D-15: REM/Design Multi-Family Whole-Building Modeling Specifications

Parameter	Requirement
REM/Design Input Mode	Detailed Mode
Housing Type	Multi-family, whole building
Number of Units	Enter the total number of units for the whole building.
Ceiling	Account for all ceilings adjacent to unconditioned space such as attics or vaulted ceilings adjacent to outdoors. Do not include any ceilings adjacent to other apartments or conditioned space. All interior walls and ceilings must be omitted.
Walls	Account for all walls adjacent to unconditioned space such as garages or outdoors. Do not model walls between units.
Floor	Account for all floors adjacent to unconditioned space such as garages, ground, crawlspace, etc. Do not include floors adjacent to other apartments or common areas.
Number of Bedrooms	When inputting the number of bedrooms, the model must account for the TOTAL number of bedrooms in the entire building, not just the number of bedrooms per dwelling unit.
Mechanical Equipment	Each model of similar equipment types must be included. When inputting mechanical equipment, each piece can be manually created, or if all pieces of equipment are identical, the number of units can be increased on the “Mechanical Equipment Properties Summary” page. The program will automatically split the system load based on capacity.

8.5.4 Multi-Family Individual Unit Modeling Specifications

8.5.4(a) In REM/Design, when in an Individual Units in a multi-family building will be modeled, and after CSD and DOE approval has been obtained, all inputs should reflect only the single unit. The individual unit specifications outlined in Table D-16 must be input into the model.

TABLE D-16: REM/DESIGN INDIVIDUAL UNIT MODELING SPECIFICATIONS

Parameter	Requirement
REM/Design Input Mode	• Detailed Mode
Housing Type	• Selection based on the unit being served. Choose one of the following: − Townhouse, end unit − Townhouse, inside unit − Apartment, end unit − Apartment, inside unit − Duplex, single unit
Level Type	• This field is required if the housing type selected is an apartment. If the building is more than one floor, select either top floor, mid-level, or lowest level.
Ceiling/Wall/Floor	• Model inputs should reflect and be appropriate for the Housing Type being served. Some of these inputs are not necessary for apartments, depending on whether they are located on the top, middle, or lower level of the building. − Ceiling/roof and floor/foundation information is not required for a mid-level apartment. − Floor/foundation information is not required for a top floor apartment. − Ceiling/roof information is not required for the lowest level apartment when apartments are vertically attached.
Number of Bedrooms	• When inputting the number of bedrooms, the model must account for the TOTAL number of bedrooms in the dwelling unit.
Mechanical Equipment	• Account for mechanical equipment located in the dwelling unit only.

8.5.5 Small Multi-family Water Heating Modeling Specifications

8.5.5(a) For *independent* storage water heaters in small multi-family buildings, the required data and modeling shall be as defined in Multi-family Whole-Building Modeling Specifications or the Multi-Family Individual Unit Modeling Specifications when only an individual unit is served.

8.5.5(b) When a *common* water heating system (one water heater serving multiple dwelling units) is present in a multi-family building, the required approach is defined by the existing equipment. For common storage/tank type water heaters, they shall be modeled the same as Multi-family Whole-Building Modeling Specifications or the Multi-Family Individual Unit Modeling Specifications when only an individual unit is served. For any other type of water heating equipment (i.e. boiler), this is outside of the program scope. The building cannot be modelled in REM/Design.

8.5.6 Duct System Leakage Modeling

8.5.6(a) The duct sealing and repair measure requires the calculation of both a Measure SIR and a Dwelling SIR using the appropriate energy audit tool. As an ECM, the duct sealing and repair measure must be cost-effective (having both a Measure SIR of ≥1.0 and the Dwelling SIR ≥1.0) at all times. CSD allows three methods for the calculation of the duct sealing and repair SIR values:

8.5.6(a1) **Option A:** Conduct a pre-duct leakage test and use the reading for the base case in the audit. To model the improvement, enter the leakage reduction as 15% leakage and estimate how much the feasible sealing work will cost. Once the duct sealing work is completed by installers, input the post-duct leakage reading into the audit in CFM25. Then input the final (actual) measure costs to confirm the final Measure SIR and Dwelling SIR values are still ≥1.0.

- Note: When ≥25 feet of duct is replaced, total duct leakage must be reduced to 10%, and the improvement must be modeled also to 10%.

8.5.6(a2) **Option B:** It is not required to conduct a pre-duct leakage test during the audit. Estimate how much duct leakage there is (based on the types of leaks present) and the cost to complete feasible sealing work (materials and labor). Then:

- Input the duct leakage estimate in the audit as the base case.
- In the improvement, estimate the final duct leakage in CFM25 based on the feasible duct sealing activities. Based on these activities, estimate the cost to complete the work.
  - Note: When ≥25 feet of duct must be replaced, Title 24 requires total duct leakage to be reduced to not more than 10%.
- Decrease or increase the estimated *base case* leakage until the Measure SIR and Dwelling SIR are 1.0. This may take several tries of re-running the audit and re-grouping the work scope measures.
- Before any duct sealing reduction work begins:
  - Installers must run the duct leakage test. If the pre-test reading is lower than the modeled base case leakage, duct sealing under DOE WAP is not feasible and it must be removed from the work scope or billed to another funding source.
  - When duct sealing is feasible, the improvement cost estimate when the Measure SIR and Dwelling SIR = 1.0 becomes the duct sealing cost maximum. Work cannot exceed that amount for the measure.
- After the proposed duct sealing work is completed, enter the post-test reading and the actual work cost into the audit to ensure that the final Measure and Dwelling SIRs are still 1.0 or greater.

8.5.6(a3) **Option C:** When duct testing and sealing is fully leveraged using another funding source, the audit base case will comply with Title 24 and assume a duct leakage of 15%. No improvement will be modeled. No SIR will be calculated.

8.5.6(b) In options A and B, if the Measure SIR and/or Dwelling SIR is ever <1.0, the agency may only be reimbursed up to the 1.0 SIR amount (agency would be responsible for any additional cost).

8.5.6(c) When duct sealing will be billed to DOE WAP, the finalized audit must include the actual pre- and post- test duct test values (in CFM25) from the CSD 706 form.

8.5.7 Shell Leakage Modeling

8.5.7(a) Air sealing activities must be included in the Dwelling SIR; however, the air sealing "measure" does not require a Measure SIR of ≥1.0. The Dwelling SIR must be ≥1.0 at all times. CSD allows three options to calculate the air sealing SIR values:

8.5.7(a1) **Option A:** Conduct a pre-blower door test and use the reading for the base case in the audit. To model the improvement, enter the leakage reduction as 5 ACH50 and estimate how much the feasible sealing work will cost. Once the air sealing work is completed by installers, input the post-blower door reading into the audit in CFM50. Then input the final (actual) measure costs to confirm the final Dwelling SIR value is still ≥1.0.

8.5.7(a2) **Option B:** It is not required to conduct a pre-blower door test during the audit. Estimate how much shell leakage there is and the cost to complete feasible sealing work (materials and labor). Then:

- Input the shell leakage estimate in the audit as the base case.
- In the improvement, estimate the final shell leakage in CFM50 based on the feasible infiltration reduction activities. Based on these activities, estimate the cost to complete the work.
- Decrease or increase the estimated *base case* leakage until the Dwelling SIR is 1.0. This may take several tries of re-running the audit and re-grouping the work scope measures.
- Before any infiltration reduction work starts:
  - Installers must run the blower door. If the pre-blower door reading is lower than the base case leakage, infiltration reduction under DOE WAP is not feasible and it must be removed from the work scope or billed to another funding source.
  - When infiltration reduction is feasible, the improvement cost estimate when the Dwelling SIR = 1.0 becomes the infiltration reduction cost maximum. Work cannot exceed that amount for the measure.
- After the proposed shell sealing work is completed, enter the final blower door reading and the actual cost into the audit to ensure that the final Dwelling SIR is still 1.0 or greater.

8.5.7(b) **Option C:** When blower door testing and sealing is fully leveraged using another funding source, the audit base case will assume a shell leakage of 5 ACH50. No improvement will be modelled. No SIR will be calculated.

8.5.7(c) In options A and B, if the Dwelling SIR is ever <1.0, the agency may only be reimbursed up to the Measure SIR = 1.0 amount (agency would be responsible for any additional cost).

8.5.7(d) When infiltration reduction will be billed to DOE WAP, the finalized audit must include the actual pre- and post-test shell sealing CFM50 values from the CSD 704 form.

8.5.8 Insulation (Ceiling, Floor, and Wall) Grades

8.5.8(a) Existing insulation shall be "graded" based on how well the insulation is installed. The default level for all existing insulation shall be a three ("III"), which presumes degraded or poorly installed material. When modeling the improvement measure, the default value will be a one ("I"), which assumes that all installed insulation will be complete, level, and without voids.

8.5.9 Mechanical Equipment Properties

8.5.9(a) Whenever possible, actual (existing) equipment information indicated on the equipment label or made available by manufacturer are to be input as existing properties, e.g., AFUE, SEER, and EF, for a furnace, air conditioner, and hot water heater.

8.5.9(b) 2022 Title 24 uses a system of SEER2, EER2, and HSPF2 for rating air conditioners and heat pumps. It is required to convert these improved mechanical equipment efficiency ratings to SEER, EER, and HSPF prior to input in the energy audit.

8.5.9(b1) Conversion tables for these efficiencies are provided in Conversion Tables for SEER2, EER2, and HSPF2.

8.5.9(c) Default properties are to be used ONLY when values are unavailable from equipment nameplates, labels, etc., and must not be used as a standard procedure.

8.5.9(c1) Using the REM/Design energy audit for change-out of mechanical equipment is strictly for “efficiency” purposes. The actual existing (not hypothetical) equipment must be represented as in its original installation; however, equipment efficiencies for air conditioners and heat pumps can be de-rated based on the policy outlined in Derating Heating and Cooling Systems.

8.5.9(d) The performance adjustment must be left at 100%. All equipment derating must follow the policy outlined in Derating Heating and Cooling Systems.

8.5.9(e) Sealed-combustion, direct-vent appliances shall be modeled to determine if they meet the SIR requirements. If not cost-effective, non-direct-vent appliances shall be utilized.

8.5.9(f) To qualify for replacement, the unit must reflect a Measure SIR of ≥1.0. Noting a piece of equipment is inoperable or using a “default” value (without some type of reliable substantiation) is not allowed.

8.5.9(g) The client file must contain justification for use of any mechanical equipment “default” including photographs (identifiable to the existing equipment being audited for efficiency change-out) and, if applicable, any printed research results. For example, a printout from the AHRI website (http://www.ahridirectory.org) referenced in the REM/Design Program “help”. This applies to any mechanical equipment measure considered for installation.

8.5.9(h) Setpoint temperatures for mechanical equipment must be set to the default settings of 68 (heating) and 78 (cooling). Clients requiring special heating and cooling may have alternative values only when justification/documentation is included in the client file.

8.5.10 Ventilation Strategy for Cooling

8.5.10(a) “Cooling Season Strategy” input shall be set to “Natural Ventilation”.

8.5.11 Mechanical Ventilation

8.5.11(a) Mechanical ventilation will be assessed (based on the CSD 540C and CSD 540D Forms) and installed during weatherization. Existing conditions will be modeled on the “Infiltration/Ventilation” page in REM/Design under the “Mechanical Ventilation System for IAQ” and are usually “Type: None”.

8.5.12 Appliances and Lighting

8.5.12(a) The “Lights & Appliances Audit Summary” tab must be used.

8.5.12(b) For the following appliances and lighting sources, the default values listed below shall be applied as in Table D-17. To apply the defaults, select the “Use in Calculations” checkbox and select the “Set Lights & Appliances Defaults” button on the top right corner of the screen.

8.5.12(c) Update the default values for only the lights and appliances that will be upgraded (measures that are ADMs). Update these values based on the existing condition.

8.5.12(d) Many of these values can be set on the “RESENT” tab prior to switching to the “Audit” tab.

8.5.12(e) For any lights and appliances not included in the table below, leave the values at the default setting.

Table D-17: Appliance and Lighting Values

Appliance	Default Values
Lighting: Interior, Exterior or Garage (DOE ADM)	• When LED lighting is part of the work scope: – Quantity: Enter the quantity of bulbs. A new entry will need to be created for each type of existing bulb (incandescent, CFL, LED, etc.) – Rate: Enter the average wattage of the lighting. Select the units of "Watts" – Use: Enter the average hours/day the light(s) are in use. Select the units of "Hours/day" – An improvement will be added to the model to calculate the Measure SIR. • When LED lighting is not part of the work scope use default values.
Refrigerator (DOE ADM)	• When refrigerator replacement is an audited measure, the Measure SIR must be calculated within the energy audit. • At least 10% of replaced refrigerators under DOE WAP must be metered. All other refrigerators must use "Lookup Data" from the DOE WAP Refrigerator and Freezer Database at: https://www.energy.gov/scep/wap/articles/refrigerator-and-freezer-energy-rating-database-search-tool • When entering the metering or lookup data into the audit, enter the kWh/year of the existing refrigerator. – Rate: Enter the kWh/year. Select the units "kWh/use" – Use: Enter 1. Select the units "Uses/year" – An improvement will be added to the model to calculate the Measure SIR. • When refrigerator replacement is not part of the work scope, use the default value.
Dishwasher	• Energy Factor (EF) 0.46 • kWh/year entry will be "0" (zero) • Place setting capacity is "12" (standard) or "8" (compact)
Range/Oven	• Select the correct "Fuel" used for cooking. • If the range and oven use different fuels, select the dominant use fuel (usually the range). • If an Induction Range or Convection Oven, select the appropriate boxes.
Clothes Dryer	• REM/Design will auto-fill the Modified Energy Factor (MEF) field for the Dryer and Washer.
Clothes Washer	• "Capacity Cubic Ft" (washer tub capacity) will be auto-filled with a default value. • The "Electric Rate", "Gas Rate", and "Annual Gas Cost" will be auto-filled with default values.
Ceiling Fans	• Model with no ceiling fans in the home, i.e. input "0" (zero).

8.5.13 SIR Calculation Methodology

8.5.13(a) When using REM/Design, the Measure SIRs and Dwelling SIR for ADMs will be calculated by the software. CSD requires that all SIRs calculated in REM/Design be calculated "Using DOE Methodology". This methodology can be selected under the Economic Factors button on the Improvement Analysis Criteria screen.

8.5.13(b) All energy efficiency measures in REM/Design and the cost to implement the measure must be carefully defined in the software. When calculating the cost to implement a measure, it shall only reflect the labor and materials needed to complete the measure.

8.5.13(c) Incidental repair costs must be tracked and reported separately in the audit.

8.5.13(d) No administrative costs shall be included in the SIR calculation.

8.5.13(e) This Dwelling SIR must be transferred to the CSD 710 form.

8.6. REM/Design & Building Model True-up with Actual Energy Bills

8.6.1 An energy usage true-up is not required for single-family buildings, mobile homes, or small multi-family audits with independent heating and/or cooling systems.

8.7. REM/Design Reports

8.7.1 CSD requires that each of the following energy audit reports be generated from REM/Design and stored in the client file (except as noted below).

8.7.1(a) CSD 710 Energy Audit and Priority List Checklist (DOE only)

8.7.1(b) REM/Design Building File Report (BFR) – Must be generated and saved from REM/Design

8.7.1(c) REM/Design Digital Building File (*.blg)

8.7.1(d) Three REM/Design Improvement Analysis Report (IAR) copies, as defined below:

8.7.1(d1) Measure Level (All): Includes all measures run in the software listed with separate Measure SIRs (measures with SIR ≥1.0 and those measures with an SIR <1.0).

8.7.1(d2) Measure Level (Final): Includes the final work scope, measures with an SIR ≥1.0 and air sealing.

8.7.1(d3) Dwelling SIR: The SIR created by grouping all ADMs with an SIR ≥1.0 (includes a line item for any incidental costs). Note: Air sealing shall be included in the Dwelling SIR calculation, even if the Measure SIR <1.0.

8.7.2 If any partial leveraging measures were identified, the energy audit reports must show the Measure SIRs of each individual measure at the full measure cost and at the partially leveraged measure cost (DOE investment). Documentation on the CSD 710 form must include the name(s) of any other source that funded each partially leveraged measure.

8.8. Quality Assurance Review—REM/Design Audits

8.8.1 To ensure accuracy and integrity of energy audits, and to assist service providers in improving the quality of audits, all energy audits are subject to review by CSD or a representative of CSD. There are two review levels: TIER 1 and TIER 2. All auditors/assessors begin at the TIER 1 level.

8.8.1(a) Auditors/assessors are required to submit all audits, including those where *no measures* were found to have an SIR ≥1.0.

8.8.2 CSD may, at its sole discretion, review any submitted energy audit for completeness and accuracy. Level of review will be determined on case-by-case basis by CSD staff and may require (re)submission of supporting documentation and/or site visit. The full energy audit submittal policy for REM/Design is provided below.

8.8.2(a) **TIER 1 Submittal**

8.8.2(a1) Tier 1 auditors/assessors must submit 100% of completed energy audits to CSD via the Local Agency Portal. Each audit submittal shall consist of the following:

- All reports listed in REM/Design Reports shall be submitted for each audit reviewed.

- Justification Images (See Justification Image Requirements for REM/Design Energy Audits)

8.8.2(a2) CSD will review a *minimum* of 60% (3/5) of the first five audits from new agencies or new auditors/assessors within an agency.

8.8.2(a3) Upon successful completion of a minimum of three audits, with minor or no changes required, and at the sole discretion of CSD, the auditor/assessor will receive a letter from CSD documenting advancement to TIER 2 review status.

8.8.2(b) **TIER 2 Submittal**

8.8.2(b1) Tier 2 auditors/assessors must submit 100% of completed energy audits to CSD via the Local Agency Portal. Each audit submittal shall consist of the following:

- All reports listed in REM/Design Reports shall be submitted for each audit reviewed.
- Although not required at the time of the initial submittal, CSD may request Justification Images on TIER 2 submissions at its discretion.

8.8.2(b2) Once an auditor/assessor has successfully advanced to TIER 2 status, CSD will review approximately 15% (1/7) of all audits submitted by each TIER 2 auditor/assessor.

8.8.2(c) "Notice of Approval" of all approved (reviewed and non-reviewed) audits submitted to CSD will be issued electronically within 3 business days of receipt of the required reports/documents listed in REM/Design Reports.

8.8.2(c1) If, during the quality assurance review, additional information is required prior to CSD approval, CSD will contact the agency electronically to request information to complete the review. This contact normally will occur within three business days of receipt of required reports/documents.

8.8.2(d) When an auditor/assessor is found to have submitted an energy audit that does not meet CSD energy audit standards, the auditor's/assessor's TIER 2 status will revert to TIER 1 technical review status.

8.8.3 Submittal of Audit Versions

8.8.3(a) For Tier 1 and Tier 2 auditors/assessors, all versions of energy audits must be submitted, including:

8.8.3(a1) Initial audit submittal

8.8.3(a2) Resubmittal(s), to address any changes to the audit based on CSD feedback

8.8.3(a3) Final audit submittal, to address one or more of the following:

- Changes in measure cost as defined in Measure Cost Calculations
- Input of final duct or shell leakage readings, in lieu of estimated leakage used for the initial improvement analysis
- Changes to the final work scope
- Any additional decisions related to full or partial measure leveraging

8.8.3(a4) Once all measures have been installed, any changes to the measure pricing or quantities must be re-submitted to CSD through the Local Agencies Portal.

8.8.4 Installation of Measures After Review

8.8.4(a) TIER 1: Installation of measures may begin immediately after notice of audit approval from CSD has been received.

8.8.4(b) TIER 2: Installation of audited ECMs with Measure SIRs ≥1.0 may begin immediately after the submittal process and need not wait for a notice of approval from CSD.

8.8.5 Small Multi-Family Audit Review

8.8.5(a) 100% of small multi-family energy audits will be reviewed by CSD due to increased complexity of modeling. These audits should be discussed with CSD prior to submittal to ensure conformance with current policy.

8.8.6 Partial Measure Leveraging Audit Review

8.8.6(a) Auditor status (Tier 1/Tier 2) is independent of the partial measure leveraging (PML) quality assurance reviews.

8.8.6(b) When an audit contains PML, the auditor/assessor must indicate “partial measure leveraging” in the audit submittal “Measure Leveraging” field. 100% of each auditor’s initial audits will be reviewed by CSD or a CSD-authorized representative.

8.8.6(c) After CSD reviews and approves a minimum of three (3) energy audits demonstrating PML with minimal or no changes required of the auditor, and at the sole discretion of CSD, the auditor will be allowed to resume their Tier 1/Tier 2 auditor status for PML files.

9. TREAT ENERGY AUDIT PROTOCOL

9.1 Applies to:

- Small multi-family (5 – 24 units) with common heating and/or cooling, or common water heating using a non-storage system (i.e., boiler)
- Large multi-family (25+ units)

9.2. TREAT Energy Audit Procedure

9.2.1 Energy Modeling Software Requirements

9.2.1(a) TREAT is an energy audit software tool provided by Performance Systems Development and approved for CSD in its weatherization programs.

9.2.1(b) CSD requires the agencies or its energy audit subcontractor to use the latest available version of the TREAT software.

9.2.1(c) TREAT software-based energy simulations shall be conducted to determine the feasibility and cost effectiveness of all available ECMs.

9.2.2 TREAT Overview

9.2.2(a) TREAT will be used to estimate annual energy consumption and energy cost savings of potential measures for the above-defined multi-family buildings. All energy and cost savings results from the TREAT model must be verified against known conditions and usage profiles.

9.2.2(b) For qualifying multi-family buildings in the DOE WAP, H&S measures and GHW measures will be installed in accordance with Audit Path Measures.

9.2.2(c) A site-specific TREAT energy audit must be used to justify all ECMs, which may only be installed when cost-effective with an SIR of ≥1.0. Use of the Priority List to justify measure installation is not applicable to these housing types.

9.2.2(d) Multi-family buildings analyzed by the TREAT software are also eligible for common area measures and additional large multi-family heating and cooling appliances which must be cost justified by TREAT audit. An SIR of ≥1.0 is required in order for any of these ECMs to be installed in TREAT-eligible buildings.

9.2.3 Energy Audit Restrictions

9.2.3(a) A TREAT energy audit is part of the assessment and cannot be run after work has been installed to justify installation or recategorization of measures.

9.2.3(b) When a TREAT audit is conducted, the audit modeling must include the features of the whole building. TREAT audit models may not be used to justify measures for individual units located within a building complex.

9.2.4 On-Site Visit Preparation

9.2.4(a) It is recommended that the following items be addressed prior to arrival:

9.2.4(a1) Review the initial building assessment or intake report which establishes the building’s eligibility to participate in the program. Verify that the accrual of benefits is sufficiently justified.

9.2.4(a2) Review 12-24 months of prior utility bills (including gas, electric, and water) to know annual utility cost by fuel type and seasonal variations.

9.2.4(a3) Identify a sampling of units that is representative of unit types, conditions, sizes, and locations.

9.2.4(a4) Arrange access to units to be reviewed with building representative and provide necessary formal notification of inspection.

9.2.4(a5) Verify availability of as-built drawings.

9.2.4(a6) Review any historical improvement data available.

9.2.4(a7) Review Operations & Maintenance records, logs, and protocols.

9.2.4(a8) Review existing mechanical equipment information as available.

9.2.4(a9) Verify availability of property representative with access to all portions of the property.

9.2.4(a10) Verify availability of Building Management staff familiar with the building facilities and history.

9.2.5 Scheduling A Site Visit and Tenant Notification

9.2.5(a) Tenant notification and scheduling of the site visits shall be the responsibility of the agency, auditor/assessor, and the property owner or its representative.

9.2.5(b) The auditor/assessor shall schedule the site visit(s) with the designated person(s) at a time that is convenient for the project contact person(s). To the extent possible, individual unit appointments should be coordinated so as to cause minimal disruption to the tenants and neighbors.

9.2.6 On-Site Visit Components

9.2.6(a) The on-site visit by the auditor/assessor is required to facilitate collection of all appropriate energy, water, and health and safety analyses, including sufficient information to complete an energy model.

9.2.6(b) The on-site visit also provides the opportunity to fully explain the DOE WAP process to the building representative, answer questions, and define mandatory participation policies. In addition, a qualified auditor/assessor shall complete the following tasks:

9.2.6(c) Project Interview

9.2.6(c1) The auditor/assessor shall interview at least one of the following designated person(s) prior to, or at the time of, the site visit:

- Property manager
- Maintenance director or maintenance staff
- Owner or owner representative

9.2.6(c2) The purpose of the interview(s) is to:

- Discuss project energy performance
- Discuss tenant comfort, health, and safety and agree on a tenant synopsis for the site visit
- Discuss any behavioral or other factors affecting energy performance (occupancy rates, tenant usage patterns, etc.)
- Discuss operations and maintenance procedures
- Address any other questions or concerns

9.2.6(c3) The interview shall include questioning on operations and maintenance issues and will address issues including, but not limited to, those identified in TREAT Energy Audit Report Requirements. If any project team member wishes their responses to remain confidential, the auditor shall respect those requests.

9.2.7 Safety and Code Observation

9.2.7(a) Each site visit shall address specific minimum health and safety checks. The following minimum health and safety checks shall be conducted and recorded in the Energy Audit Report or form as listed below:

9.2.7(a1) Note lead, asbestos, or other environmental hazards in the CSD 540 Assessment Form, based on age of building or location, and in conformance with the EPA RRP Rule, Department of Public Health, and CAL/OSHA Title 8 Standards.

9.2.7(a2) Assess mold and moisture present in unit and common area, documented on the CSD 540A Form.

9.2.7(a3) Note structural, electrical, and mechanical system issues in the CSD 540 Form.

9.2.7(a4) Conduct combustion Appliance Safety Testing on the CSD 700 Form Series.

9.2.8 Visual Inspection and Diagnostic Testing Protocols

9.2.8(a) The site visit shall require visual inspections and diagnostic testing of the building envelope, HVAC, combustion appliances, and lighting systems. Minimum visual and diagnostic testing criteria are provided in the CSD TRM Appendices A, B, and C. These documents provide the minimum required testing procedures for Combustion Appliance Safety, Duct Leakage Testing, and Shell Leakage Testing.

9.2.8(b) Shell leakage testing is required to be conducted on a representative sample number of units in accordance with CSD contracts, standards, and policy documents. Multi-family buildings of four stories and more are excluded from these sampling requirements.

9.2.8(c) Where the CSD standards do not address specific diagnostic tests applicable to the commercial systems, BPI standards for Multi-family Building Analyst and CEC HERS II standards shall apply. Where conflicts exist between these two standards, the most conservative standard shall apply.

9.2.8(d) BPI Multi-family Building Analyst standards are available for download at BPI's website (www.bpi.org). The California Title 24 Energy Efficiency Standards in use for HERS II are available for download at the Energy Commission's website at http://www.energy.ca.gov/title24.

9.2.8(e) The auditor/assessor shall identify any building information required to complete the energy and cost analysis. At a minimum, all relevant data listed in TREAT Energy Audit Report Requirements of this document shall be collected and applied in the energy modeling and analysis phase of the audit.

9.2.9 Health & Safety Versus ECM Replacement

9.2.9(a) For the TREAT energy audit, any common heating or cooling (and associated thermostats), and/or water heating appliance that has an identified H&S condition first requires an energy audit to determine if the appliance will be replaced as an energy efficiency upgrade as described in Audit Path Health & Safety (H&S) Measures.

9.2.9(b) These appliances have an established reimbursement rate for H&S repair or replacement, and no established measure maximum for energy efficiency upgrade (the maximum will be determined by the energy audit).

9.2.10 On-Site Unit Inspection Sampling Protocols

9.2.10(a) At least one in seven (1/7) of every unit type (defined as having same/similar floor plan), with representation from differing building floors and including all four building orientations, shall be inspected. In no case shall the inspection of units be <10% of total units.

9.2.10(b) The auditor/assessor will ensure that a discussion of unit sampling addresses special building circumstances that may result in an increased level of unit inspections and testing.

9.2.11 Renewable Energy

9.2.11(a) During the on-site visit, the auditor/assessor may also examine, evaluate, and propose to incorporate renewable energy opportunities including, but not limited to solar hot water.

9.2.11(b) Any existing renewable energy systems (wind, solar thermal, solar PV, fuel cell, etc.) shall be included in the audit analysis.

9.3. Energy Modeling and Analysis Process

9.3.1 An energy model of a multi-unit building's pre- and post-retrofit performance shall be completed using building plans, visual inspection data, and diagnostic data collected during the on-site visits.

9.3.2 Audit emphasis should be placed on the assumptions that have the most impact on estimated energy savings.

9.3.3 All major assumptions used to develop the energy model and analysis shall be clearly stated in the final report.

9.3.4 Equipment efficiencies for air conditioners and heat pumps can be derated based on the policy outlined in Derating Heating and Cooling Systems.

9.3.5 When certain building features are inaccessible and cannot be physically verified, default values from Title 24 for existing buildings shall be used as the conditions for the energy model and analysis.

9.4. Utility Rates

9.4.5(a) Utility rates are used for documentation of historical energy charges, estimated monetary savings when energy efficient measures are implemented, and justification of energy savings measures based on SIR.

9.4.5(b) Model the building using the current local utility rate schedules as verified during the review of client utility bills to document historic energy costs and predictions of future energy costs accountable to the building owner or building tenant. When possible, include tiered rate structures, demand charges, time of use charges, and usage fees in the utility rate.

9.4.5(c) For purposes of determining SIR of each proposed ECM, the energy consultant shall model electricity and natural gas utility rates using the blended utility rates contained in Blended Utility Rates & Effective Useful Life (EUL) Inputs. These rates are based on statewide and utility-wide blended market rates.

9.5. TREAT Building Model True-up

9.5.1 Building model/energy use true-up is required for all whole-building projects where the TREAT energy audit is required.

9.5.1(a) The true-up must demonstrate that the building has been modeled correctly. The energy model shall be calibrated to actual utility billing data, based on master-metered data or aggregation of individual unit energy bills.

9.5.1(b) When individual bills are used, billing data shall be collected from at least 50% of qualified units. If this billing data minimum cannot be met for any reason, a waiver request shall be submitted to CSD, and an approval received, before audit work may proceed. Waivers can be requested from treat@csd.ca.gov.

9.5.2 Modeled baseline energy consumption shall be calibrated to monthly utility bills for a minimum of twelve months. The intent is to qualify the energy model by demonstrating similarity to the metered energy usage over a 12-month period.

9.5.2(a) The energy model estimates of electricity and natural gas should calibrate to actual monthly consumption to ±10%.

9.5.2(b) Typical Meteorological Year (TMY) 30-year average weather data can be used in lieu of actual year weather, which may be difficult to obtain.

9.5.3 Any adjustments made to the building description inputs used to calibrate the simulated building to actual energy usage shall be justified with explicit, transparent information and documented in the "Model Calibration" section of the TREAT Energy Audit Report.

9.5.4 In the event that the building is served by more than one meter, the bills for those meters shall be aggregated against the building calculated consumption as a whole.

9.6. Savings to Investment Ratio (SIR) Calculations

9.6.4(a) When using TREAT, the individual Measure SIRs and Dwelling SIR shall be calculated automatically by the software.

9.6.4(a1) Measure cost calculations shall be handled in accordance with the policies of ADM Cost Calculations.

9.6.4(a2) Measure buy-down shall be addressed in accordance with Measure Buy-down.

9.6.4(a3) Effective Useful Life shall be calculated in accordance with TREAT EUL.

9.6.4(a4) "Measure SIR" and "Dwelling SIR" shall be calculated in accordance with Developing an Audit Work Scope.

9.7. TREAT Energy Audit Report Requirements

9.7.1 The following format is provided as a suggested template for the TREAT energy audit report generation. The template identifies the minimum scope and level of detail that is to be included in all reports submitted to CSD.

9.7.2 Programmatic requirements of the DOE WAP may be addressed in an addendum to the submittal package but is not necessarily part of an energy audit report prepared by an energy consultant.

9.7.3 ENERGY AUDIT REPORT FORMAT

9.7.3(a) **Section 1: Executive Summary**

9.7.3(a1) Summarize the main points of the project. When possible, labeled tables and graphs should be used to present data.

9.7.3(a2) General Overview

- Project Description
  - Location, building configurations
  - Building sizes, # units and common areas description, utilities, energy cost summaries
  - Statement of eligibility: verify eligibility of the property
    - Income Eligibility Criteria
      - Property appears on HUD/DOE or USDA/DOE eligibility list; or
      - At least 66% of the units in the building are income qualified
    - Building Eligibility Criteria
      - Recent building upgrades have not already been performed
    - Accrual of benefits
      - Measures will result in reduction of tenants' energy costs; or
      - Demonstrated benefit to tenant as outlined in DOE WPN 22-12 if tenant energy cost not directly paid by tenant
    - Maximum Allowable Benefit for Property
      - Identification of maximum allowable benefit for property based on number of units times the per-unit funding limit
  - Summary of site visit (dates, interviews, project team)
- Description of any special analysis or conditions
- Historical energy use summary
- Recommended measures summary
  - Name of measure
  - Cost of measure
  - Recommended improvement package documentation arranged in descending order of SIR
    - Total Cost
    - Total Dwelling SIR

        - Total CSD Weatherization Program Contribution
        - Total Owner Contribution
        - Total Contribution of non-federal funds used for measure “buy-down”
    - Measures evaluated but not recommended
        - Description
        - Cost
        - SIR
        - Documentation of non-feasibility (already installed, not feasible, etc.)
    - Total and measure specific projected energy use summary after proposed measure package implementation

9.7.3(b) **Section 2: Existing Conditions**

9.7.3(b1) The narrative section of the report should guide the reviewer through the steps taken to conduct the energy audit and analysis. When applicable, labeled photos shall be included as defined below.

9.7.3(b2) Existing Building Conditions

- Site layout
- Number of units
- Occupancy
- Building construction types
- Number of stories
- Year built
- Total building area identified by use (residential community/common, commercial)
- History of previous retrofits or rehabs
- Other significant building features
- Photos as needed to document existing building conditions.

9.7.3(b3) Existing building components and energy systems

- Building envelope
    - Wall construction and insulation
    - Roof construction and insulation
    - Types of windows found on each face of building
    - Photos, as relevant
- Common area lighting
    - Fixture type
    - Lamp and ballast type
    - Quantity of lamps per fixture
    - Fixture wattage
    - Quantity of fixtures
    - Spaces served
    - Lighting control
    - Annual/daily hours used
    - Photos, as relevant
- Water fixtures
    - Common area fixtures
        - List all fixtures using hot water (e.g., common lavatories, laundry, kitchen, etc.)
        - Water usage for each fixture, as relevant
        - Code requirements for each fixture

        - Photos, as relevant
    - Unit fixtures
        - List all fixtures using hot water (e.g., lavatory, laundry, kitchen)
        - Water usage for each fixture, as relevant
        - Code requirements for each fixture
        - Photos, as relevant
    - HVAC systems
        - Heating system description
            - Make, model, age, capacity, and measured characteristics of all heating equipment
            - Characterization of distribution system
            - Photos of relevant equipment
        - Cooling system description
            - Make, model, age, capacity, and measured characteristics of all cooling equipment
            - Characterization of distribution system
            - Photos of relevant equipment
        - Water heating description
            - Make, model, age, capacity, and measured characteristics of all water heating equipment
            - Characterization of distribution system, regardless of type (i.e., standard storage/tank, boiler, etc.)
            - Photos of relevant equipment
    - Forced ventilation systems
        - Make, model, age, capacity, and measured characteristics of all heating equipment
        - Ability of ventilation system to provide adequate ventilation
        - Photos of relevant equipment
    - Annual utility bill breakdown
        - Monthly utilities breakdown for all applicable fuels

9.7.3(c) **Section 3: Evaluated Measures**

9.7.3(c1) Recommended energy efficiency measures

- Short narrative of each recommended energy efficiency measure should include all replacement measure parameters.
- Recommended replacement specifications
- Installed cost summary of measure
- Projected annual energy and monetary savings
- Measure SIR
- Measure EUL

9.7.3(c2) Energy efficiency measures <u>not</u> recommended

- Short narrative of each measured investigated and reasons why it is not recommended.

9.7.3(c3) Recommended health and safety measures

- Short narrative of recommended health and safety measures including description, frequency, and cost.

9.7.3(d) **Section 4: Cost Benefit Analysis**

9.7.3(d1) Table of all reviewed measures in order of decreasing SIR:

- Baseline measure description

- Improvement measure description
- Total cost of measure
- Portion of non-federal buy down funds for each measure
- Baseline measure fuel usage
- Fuel usage of proposed measure
- Measure savings
- Measure EUL
- Measure SIR

9.7.3(d2) Package cost analysis

- Total cost of all improvements
- Portion of non-federal buy down funds for each measure
- Baseline package fuel usage
- Fuel usage of proposed work scope
- Dwelling SIR

9.7.3(e) **Section 5: Analysis**

9.7.3(e1) Analysis overview

- Overview of energy simulation tool(s) used and order of operations
- Summary of the approach, and detailed calculations, used in any exceptional calculations
- True-up of base model energy consumption to measured usage

9.7.3(e2) Utility analysis and end use breakdown

- Describe the applicable end uses for each type of fuel at the project and show a breakdown of the annual energy usage and energy cost by fuel type. The auditor/assessor shall:
  - Graph energy usage for each fuel type for a minimum of 12 months.
  - Review the utility rate structure to determine if it seems appropriate for the project.
  - Make a recommendation for further investigation if the auditor/assessor finds that the rate structure does not match the utility data.

9.7.3(e3) Source of information

- Briefly describe all sources of information used to inform the analysis, including:
  - Source and scope of utility billing data supplied to the auditor/assessor including the data source, the duration in months that the data covers, and whether the auditor/assessor received copies of the actual utility bills or electronic interval data
  - Construction cost information used in economic analysis
  - Whether building plans or site verified data were used in the analysis
  - Any discrepancies between plans and verified conditions
  - Utility rate and schedules
  - Source of deemed energy savings

9.7.3(e4) Energy Model Inputs and Assumptions

- State any assumptions used when analyzing energy and water utility data.
- Reference the CSD 696 Multi-Family Energy Audit Bid Request Form as well as the building simulation program input file.

9.7.3(e5) Full Documentation Energy Model Inputs and Outputs

- TREAT Reports
  - Actual Model to Billing Report
  - Base Building Data Report

- Model Energy Comparison Report
- Base Load Reports
  - Base Building
  - Recommended Package
- Improvement Package Report

9.7.3(f) **Section 6: Qualifications and Certifications**

9.7.3(f1) Names and qualifications (as applicable) of parties responsible for following:

- Project management
- Energy auditing and analysis
- Building assessment (if different from the auditor/assessor)
- Construction cost estimating (if different from above)

9.7.3(g) **Section 7: Representation**

9.7.3(g1) Include a representation from an officer or owner of the firm conducting the Audit stating that the Audit meets the DOE WAP audit specifications without exception, and that the final Audit Report has been reviewed for quality assurance purposes by a principal or officer of the firm.

9.7.3(g2) The TREAT energy audit submittal checklist is provided in Table D-18 to assist the auditor/assessor in the preparation of the total audit submittal.

TABLE D-18: TREAT ENERGY AUDIT SUBMITTAL CHECKLIST

Submittal Package	Compliant?	
	Yes	No
Includes TREAT files		
General Overview		
Report is complete and organized		
Executive summary includes recommended measure package organized by descending SIRs		
Measure package cost and SIR clearly identified		
Health and safety measures clearly identified		
Consistent information used throughout report		
Report demonstrates property eligibility and sufficient funding available based on number of qualified units		
Site Evaluation		
Includes names of the auditor/assessor and site representatives interviewed		
Building size and occupancy reported		
Sufficient description building envelope including windows, walls, roof, etc.		
At least 1/7 of each unit type inspected		
At least 10% of total units inspected		
Comprehensive inventory of existing lighting, water heating, space heating and space cooling equipment, etc.		
Comprehensive inventory of existing hot water fixtures (lavatories, showers, sinks, bathtubs, water closets)		
Sufficient detail of existing heating equipment		
Sufficient detail of existing cooling equipment		

TABLE D-18: TREAT ENERGY AUDIT SUBMITTAL CHECKLIST

Submittal Package	Compliant?	
	Yes	No
Sufficient detail of existing water heating equipment		
Sufficient detail of existing ventilation equipment		
CAS testing performed per CSD general policy		
Environmental Hazard testing performed per CSD Health & Safety policy		
12-24 months of utility bills included to verify fuel usage and cost		
Analysis		
TREAT analysis used for calculations		
TREAT input values consistent with data collected during site visit		
Sample calculations provided for analysis performed outside of TREAT		
Projected energy usage true-up to utility bills performed		
Projected energy usage is reasonable with respect to industry standards		
All savings calculations are reasonable and within industry standard ranges (Note: When savings calculations are outside of expected ranges, TREAT input files or other means may be reviewed to verify accuracy and reasonable assumptions, to ensure reasonable savings.)		
All measure EULs are within industry standard ranges		
All SIR calculations are executed properly		
Recommended Measures		
All measures listed in measure package are allowed measures		
Total requested funds do not exceed average maximum per unit		
Total Dwelling SIR ≥1.0 regardless of funding source		
Verifiable source of any non-federal funds used to implement package		
All measures described with enough detail to justify measure feasibility		

9.8. Quality Assurance Review—TREAT Audits

9.8.1 CSD reviews all TREAT energy audit packages and their components to ensure that only cost-effective ECMs have been identified. Through the review process, if TREAT audit results are found to not be defensible based on information from the site visit and/or via the audit measure calculations, the TREAT model must be re-evaluated.

9.8.2 100% of TREAT energy audits must be submitted and reviewed by CSD for accuracy and completeness. Agencies and auditors shall also be required to include with their audit submittals any audits where no measures are found to have an SIR of ≥1.0.

9.8.3 Questions about data collection or the modeling process should be directed to CSD's third-party representative at treat@csd.ca.gov for assistance. Due to the complex nature of these energy audits, questions about the review process will be handled on a case-by-case basis, where the reviewer will provide direct agency mentoring to the auditor/assessor who submitted the audit.

9.8.4 100% of the TREAT audits submitted by agencies to CSD will be sent to DOE for review and approval by the DOE project officer. All TREAT audits that will apply DOE funds (in any amount) must be approved by DOE prior to the start of work. Approvals will be on a case-by-case basis.

9.8.5 The following process will be applied to all submitted TREAT energy audits.

9.8.5(a) The auditor/assessor will run an initial audit with all potential measures identified that might be installed.

9.8.5(b) The auditor/assessor will submit the draft narrative report, scope of work, energy audit documentation, and "TPG" report file to the Local Agency Portal. A CSD third-party representative will review these initial components to ensure that all potential measures are correctly identified. During this review, the reviewer will:

9.8.5(b1) Review bill disaggregation compared to the base model

9.8.5(b2) Review modeling parameters of major mechanical equipment

9.8.5(b3) Check agreement between documented conditions and software

9.8.5(b4) Verify reasonable human factors (base case) are assumed

9.8.5(b5) Analyze measure assumptions

9.8.5(b6) Evaluate external calculations

9.8.5(b7) Compare EULs used against those listed in TREAT EUL.

9.8.5(c) If there are questions on specific measures, CSD or its representative may request additional detail from the auditor/assessor.

9.8.5(d) Once the audit has been approved on technical merit, CSD will generate a Preliminary Approval Letter. Upon receipt, the agency may begin the procurement process (if subcontracting work).

9.8.5(d1) The Preliminary Approval Letter will define the approved measures including the approved energy savings and EULs. Measure cost is not included in this letter as actual measure costs may change during procurement.

9.8.6 After final bids have been procured by the agency for all potential measures, the CSD 871 Pre-Weatherization Scope of Work/Sources & Uses (SOW/S&U) Worksheet must be completed and submitted to the Local Agency Portal in accordance with the form instructions provided in the electronic file. The spreadsheet utilizes information provided in the CSD's Energy Audit Approval letter and the final bid costs to identify the measure energy savings, measure cost, EUL, and SIR.

9.8.7 For measures with an SIR <1.0, where external non-federal funds are applied, the amount and source of external funds will be identified. This spreadsheet must be approved before any measures may be installed.

9.8.8 In addition to the CSD 871 Pre-Weatherization SOW/S&U Spreadsheet, submit these documents concurrently:

9.8.8(d1) Description and justification for any specific ADMs and Health & Safety measures being requested, including line items and cost allocations.

9.8.8(d2) Demonstration of the benefits of weatherization will accrue to the resident of the property if master-metered (to be kept on file at agency).

9.8.8(d3) State Historic Preservation Office (SHPO) Review—Verification that property has been submitted for SHPO review (if required) and approved for all installed measures (to be kept on file at agency).

9.8.8(a) The SOW/S&U Worksheet submittal will initially be reviewed by CSD's third-party representative, then submitted to the DOE WAP Project Officer for approval.

9.8.8(b) When DOE approval is received, a Final Scope of Work Approval Letter will be issued by CSD in coordination with its third-party representative. Once this letter is received, measure installations may begin.

9.8.8(c) After the entire multi-family job is completed, a CSD 872 Post-Weatherization SOW/S&U Worksheet shall be submitted to the Local Agency Portal. The worksheet shall be updated with all actual ECM costs, and final Measure SIRs and Dwelling SIR. All audits returned for correction by the third-party reviewer will be reviewed again upon re-submittal, to the extent deemed necessary by the reviewer.

10. NON-ENERGY IMPACTS AND BLENDED UTILITY RATES

10.1. Non-Energy Impacts (NEIs)

10.1.1 NEIs identify benefits for weatherization recipients beyond the energy cost savings gained from installing energy efficient measures. NEIs include benefits such as: reduced emissions and related environmental costs, water savings, comfort and productivity improvement and reduced risk of utility service disruptions or price spikes.

10.1.2 Including NEIs in the DOE WAP increases the cost-effectiveness of WAP measures, and also may increase the number of measures that can be installed with DOE WAP funds.

10.1.3 To address the long-term impacts of carbon emissions, CSD has adopted the Social Cost of Carbon (SCC) NEI as a fuel cost modifier. There is a fuel cost modifier for each fuel type as detailed in Table D-19.

TABLE D-19: NON-ENERGY IMPACT MODIFIERS

Fuel Type	Social Cost of Carbon Fuel Cost Modifier
Electric (per kWh)	$ 0.0199
Natural Gas (per therm)	$ 0.2804
Liquid Propane (per gallon)	$ 0.3048
Heating Oil (per gallon)	$ 0.5401

10.2. Blended Utility Rates

10.2.1 REM/Design and TREAT audits are modeled using electricity and natural gas blended utility rates. The utility blended rates provided below will be updated annually in accordance with the DOE WAP policy. CSD will notify agencies of the updated rates and will provide a transition period by which the new rates must be applied.

10.2.2 Rates are based on California utility-wide blended market rates. Applicable monthly service charges are factored into these rates.

10.2.2(a) Table D-20 shows the blended electric rate for the major electric utilities.

10.2.2(b) Table D-21 shows the blended natural gas rate for the major gas utilities.

10.2.2(c) If a utility is not explicitly listed in Table D-20 or Table D-21, use the “All Other Utilities” values.

10.2.3 For the utilities listed in Table D-20 and Table D-21, the value in the column “Blended Rates + SCC Fuel Cost Modifier” must be used when calculating the SIRs of ADMs.

10.2.3(a) For all other heat source fuel types such as wood, propane, fuel oil, kerosene, and others, fuel costs shall be based on available billing data (actual billing rates) on a case-by-case basis.

10.2.3(b) For dwelling using other heat source fuel types, the SCC fuel cost modifier may be added to the actual billing rate.

10.2.4 Fuel switching projects must continue to use actual customer fuel costs and cannot include the SCC fuel cost modifier.

Table D-20: Blended Electric Rate by Utility

Utility	Electric Blended Rate ($/kWh)	Blended Rate + SCC Fuel Cost Modifier ($/kWh)
PG&E	$ 0.259	$ 0.279
SCE	$ 0.213	$ 0.233
SDG&E	$ 0.307	$ 0.327
LADWP	$ 0.212	$ 0.232
SMUD	$ 0.162	$ 0.182
Burbank MUD	$ 0.159	$ 0.179
Glendale Water and Power	$ 0.217	$ 0.237
Pasadena Water and Power	$ 0.210	$ 0.230
Imperial Irrigation District	$ 0.144	$ 0.164
All Other Utilities	$ 0.221	$ 0.241

Table D-21: Blended Natural Gas Rate by Utility

Utility	Natural Gas Blended Rate ($/therm)	Blended Rate + SCC Fuel Cost Modifier ($/therm)
PG&E	$ 1.71	$ 1.99
SCG	$ 1.46	$ 1.74
SDG&E	$ 1.75	$ 2.03
All Other Utilities	$ 1.58	$ 1.86

11. EFFECTIVE USEFUL LIFE (EUL) INPUTS

11.1. REM/Design and Priority List Maximum EUL

11.1.1 For ADM calculations, the maximum Effective Useful Life (EUL) of ADMs shall be determined using values listed in Table D-22 for the REM/Design energy audit. In the event that a proposed EUL would exceed those listed below, justification must be provided in writing for review and approval by CSD before the measure will be installed.

Table D-22: EULs of Audit-Driven Measures

Measure Type	Audit-Driven Measures	EUL (in years)
Building insulation	Attic insulation: blown in and batt	30
Building insulation	Attic insulation: all other types	20
Building insulation	Floor insulation: loose and batt types installed in fully en-closed air-tight cavities, and rigid insulation	30
Building insulation	Floor insulation: all other types including loose-fill and batt not installed in fully enclosed air-tight cavities	20
Building insulation	Kneewall insulation: loose and batt types installed in fully enclosed air-tight cavities, and rigid insulation	30
Building insulation	Kneewall insulation: all other types including loose and batt types not installed in fully enclosed air-tight cavities	20
Building insulation	Wall insulation: dense pack insulation, rigid insulation and full-cavity batt insulation in fully enclosed air-tight cavities	30
Building insulation	Wall insulation: all other types	20
Ducts/infiltration	Air sealing	10
Ducts/infiltration	Duct sealing and repair	10
Doors and windows	Door replacement	20
Doors and windows	Window replacement	20
HVAC systems	Heating system replacement: fossil fuel fired furnaces and boilers, standard and condensing	20
HVAC systems	Heating system replacement: all other heating systems except heat pumps	18
HVAC systems	Air conditioner replacement	15
HVAC systems	Evaporative cooler	15
HVAC systems	Heat pump replacement: ducted and non-ducted	15
HVAC systems	Programmable thermostat	15
Baseloads	LED lighting	15
Baseloads	Showerheads	15
Baseloads	Refrigerator replacement	15
Baseloads	Water heater replacement: gas or electric	13
Baseloads	Water heater replacement: heat pump	15

11.2. TREAT EUL

11.2.1 The EULs utilized in Table D-23 below are the DOE-approved maximum useful lives of these measures and are to be used in the TREAT energy audit. If the auditor/assessor recommends EULs exceeding the DOE-approved maximums, justification must be provided and is subject to review prior to the start of any work.

TABLE D-23: EULS FOR TREAT-AUDITED MEASURES

Measure Type	Measure Name	Life (in years)*
Building insulation	Attic insulation: blown in and batt	30
Building insulation	Attic insulation: all other types	20
Building insulation	Sillbox insulation	20
Building insulation	Foundation wall insulation	20
Building insulation	Slab insulation	20
Building insulation	Floor insulation: loose and batt types installed in fully enclosed air-tight cavities, and rigid insulation	30
Building insulation	Floor insulation: all other types including loose and batt not installed in fully enclosed air-tight cavities	20
Building insulation	Wall insulation: dense pack insulation, rigid insulation and full-cavity batt insulation in fully enclosed air-tight cavities	30
Building insulation	Wall insulation: all other types	20
Building insulation	Kneewall insulation: loose and batt types installed in fully enclosed air-tight cavities, and rigid insulation	30
Building insulation	Kneewall insulation: all other types including loose and batt types not installed in fully enclosed air-tight cavities	20
Building insulation	Duct insulation†	20
Building insulation	White roof coating†	7
Building insulation	Radiant barrier †	15
Ducts/infiltration	Whole house air sealing	10
Ducts/infiltration	Duct sealing and repair	10
Doors and windows	Window replacement	20
Doors and windows	Door replacement	20
HVAC systems	Thermal vent damper	10
HVAC systems	Electric vent damper †	10
HVAC systems	Intermittent Ignition Device (IID) †	10
HVAC systems	Electric vent damper and IID †	10
HVAC systems	Flame retention burner †	10
HVAC systems	Heating system replacement: fossil fuel fired furnaces and boilers†, standard and condensing	20
HVAC systems	Heating system replacement: all other heating systems except heat pumps	18
HVAC systems	Smart/programmable thermostat	15
HVAC systems	Air conditioner replacement	15
HVAC systems	Evaporative cooler	15
HVAC systems	Heat pump replacement	15
Baseloads	Lighting retrofit: LED	30,000 hours

Table D-23: EULs for TREAT-Audited Measures

Measure Type	Measure Name	Life (in years)*
Baseloads	Lighting retrofit: halogen †	4,000 hours
Baseloads	Refrigerator replacement	15
Baseloads	Water heater tank insulation	13
Baseloads	Water heater pipe insulation	13
Baseloads	Low flow showerhead†	15
Baseloads	Water heater replacement: gas or electric	13
Baseload	Water heater replacement: heat pump	15
Baseloads	Water heater setpoint reduction†	13

* Except where otherwise noted.
† Measures that are not currently incorporated into the CSD measure list for small multi-family buildings with common systems or large multi-family buildings may be considered for incorporation into the TREAT audit; however, an approved CSD waiver would be required.

12. PRIORITY LIST TABLES

12.1 Priority List tables, with minimum specifications, are included for single-family, mobile home and multi-family in Table D-24, Table D-25, and Table D-26 respectively.

Table D-24: Minimum Specifications for Single-Family Priority List

Single-Family Priority List *Measures must be installed in order as listed below.*
Mandatory Measures *Mandatory measures may only be skipped if physically impossible to install - regardless of funding source.*
1. Health and safety measures *When DOE-Specific feasibility criteria are met the following may be installed: CO alarms, smoke alarms, CVA venting, kitchen exhaust, lead-safe weatherization, LHR-H&S support, and mechanical ventilation.*
2. LED bulbs *Replace all existing thread-based incandescent, halogen or compact fluorescent lighting used for a minimum of one hour per day.*
3. Infiltration reduction *Follow shell sealing procedures defined in TRM Appendix C and in the CSD 704 instructions.* *Apply the Target value of 1 CFM/sq. ft. of conditioned floor area.*
4. Ducting repair and sealing *Follow duct sealing procedures defined in TRM Appendix B. Title 24 (1/1/2023) requirements apply.*
5. Duct insulation *Insulate ducts located outside of the thermal boundary to R-8. Insulate to R-12 if exposed to the exterior.*
6. Ceiling insulation *Insulate all accessible attics based on Title 24 requirements (up to R-49). When required by the local jurisdiction, sealing of the attic floor and installation of IC-rated fixtures or approved cover also must be installed.*
7. Wall insulation *When no insulation exists, insulate wall cavities to capacity with dense pack insulation to a minimum R-13 for 2x4 framing, and R-19 for 2x6 framing.*

Table D-24: Minimum Specifications for Single-Family Priority List

Single-Family Priority List *Measures must be installed in order as listed below.*
8. Floor insulation ***(for homes with propane or oil-fired primary heat)*** *When no insulation is existing, insulate floors to R-30 or to full joist capacity. Installation of insulation must include complete ground moisture barrier over any exposed dirt floor.*
Optional Measures *Optional measures may only be installed if all other applicable mandatory measures are also installed.*
9. Faucet aerators *Replacement aerator must be ≤ 1.8 GPM in a kitchen and ≤ 1.2 GPM in a bathroom at 60 psi.*
10. Showerheads ***(low-flow, handheld, thermostatic)*** *Replacement showerhead must be ≤ 1.8 GPM at 80 psi.*
11. Water heater insulation *Insulation minimum of R-11.*
12. Water heater pipe insulation *Insulate the first 6' of cold-water lines nearest the water heater and any accessible hot water lines to minimum one inch or minimum R-7.7 based on pipe diameter.*
13. Refrigerators *Refrigerator replacement as justified by the SIR calculated using the CSD 540E form.*
14. Central heat pump ***(to replace primary ducted electric resistance FAU and AC combo)*** *Heat pump must be a minimum 15 SEER/8.2 HSPF (or equivalent SEER2/HSPF2) and include an EC air handler motor.* *California equivalent SEER/HSPF are 14.3 SEER2/7.5 HSPF2 (split-system), 13.4 SEER2/6.7 HSPF2 (package unit)*
15. Mini-split heat pump ***(to replace primary non-ducted electric resistance heat and non-ducted AC)*** *Mini-split heat pump must be minimum 19 SEER/10 HSPF.*
16. Window/wall AC ***(primary and manufactured pre-2014)*** *Replacement window/wall AC must be minimum 12 CEER or higher and of the same or lesser BTU capacity.*

Table D-25: Minimum Specifications for Mobile Home Priority List

Mobile Home Priority List *Measures must be installed in order as listed below.*
Mandatory Measures *Mandatory measures may only be skipped if physically impossible to install - regardless of funding source.*
1. Health and safety measures *When DOE-Specific feasibility criteria are met the following may be installed: CO alarms, smoke alarms, CVA venting, kitchen exhaust, lead-safe weatherization, LHR-H&S support, and mechanical ventilation.*
2. LED bulbs *Replace all existing thread-based incandescent, halogen or compact fluorescent lighting used for a minimum of one hour per day.*
3. Infiltration reduction *Follow shell sealing procedures defined in TRM Appendix C and in the CSD 704 instructions.* *Apply the Target value of 1 CFM/sq. ft. of conditioned floor area.*
4. Ducting repair and sealing *Follow duct sealing procedures defined in TRM Appendix B. Title 24 (1/1/2023) requirements apply.*

Table D-25: Minimum Specifications for Mobile Home Priority List

Mobile Home Priority List *Measures must be installed in order as listed below.*
5. Ceiling insulation *Fill ceiling to capacity with blown insulation.*
Optional Measures *Optional measures may only be installed if all other applicable mandatory measures are also installed.*
6. Replace single-paned metal-framed windows ***(for homes with propane or oil-fired primary heat)*** *Low-E double-paned windows must have a U-value of 0.30 or less. Single pane windows with storm windows are not feasible for replacement.*
7. Faucet aerators *Replacement aerator must be ≤ 1.8 GPM in a kitchen and ≤ 1.2 GPM in a bathroom at 60 psi.*
8. Showerheads ***(low-flow, handheld, thermostatic)*** *Replacement showerhead must be ≤ 1.8 GPM at 80 psi.*
9. Water heater insulation *Insulation minimum of R-11.*
10. Water heater pipe insulation *Insulate the first 6' of cold-water lines nearest the water heater and any accessible hot water lines to minimum one inch or minimum R-7.7 based on pipe diameter.*
11. Refrigerators *Refrigerator replacement as justified by the SIR calculated using the CSD 540E form.*
12. Window/wall AC ***(primary and manufactured pre-2014)*** *Replacement window/wall AC must be minimum 12 CEER or higher and of the same or lesser BTU capacity.*

Table D-26: Minimum Specifications for Multi-Family Priority List

Multi-Family Priority List *Measures must be installed in order as listed below.*
Mandatory Measures *Mandatory measures may only be skipped if physically impossible to install - regardless of funding source.*
1. Health and safety measures *When DOE-Specific feasibility criteria are met the following may be installed: CO alarms, smoke alarms, CVA venting, kitchen exhaust, lead-safe weatherization, LHR-H&S support, and mechanical ventilation.*
2. LED bulbs *Replace all existing thread-based incandescent, halogen or compact fluorescent lighting used for a minimum of one hour per day.*
3. Infiltration reduction *Follow shell sealing procedures defined in TRM Appendix C and in the CSD 704 instructions.* *Apply the Target value of 1 CFM/sq. ft. of conditioned floor area.*
4. Ducting repair and sealing *Follow duct sealing procedures defined in TRM Appendix B. Title 24 (1/1/2023) requirements apply.*
5. Duct insulation *Insulate ducts located outside of the thermal boundary to R-8. Insulate to R-12 if exposed to the exterior.*

Table D-26: Minimum Specifications for Multi-Family Priority List

Multi-Family Priority List *Measures must be installed in order as listed below.*
6. Ceiling insulation *Insulate all accessible attics based on Title 24 requirements (up to R-49). When required by the local jurisdiction, sealing of the attic floor and installation of IC-rated fixtures or approved cover also must be installed.*
7. Wall insulation *When no insulation exists, insulate wall cavities to capacity with dense pack insulation to a minimum R-13 for 2x4 framing, and R-19 for 2x6 framing.*
Optional Measures *Optional measures may only be installed if all other applicable mandatory measures are also installed.*
8. Faucet aerators *Replacement aerator must be ≤ 1.8 GPM in a kitchen and ≤ 1.2 GPM in a bathroom at 60 psi.*
9. Showerheads ***(low-flow, handheld, thermostatic)*** *Replacement showerhead must be ≤ 1.8 GPM at 80 psi.*
10. Water heater insulation *Insulation minimum of R-11.*
11. Water heater pipe insulation *Insulate the first 6' of cold-water lines nearest the water heater and any accessible hot water lines to minimum one inch or minimum R-7.7 based on pipe diameter.*
12. Refrigerators *Refrigerator replacement as justified by the SIR calculated using the CSD 540E form.*
13. LED tube lighting *Replace fluorescent tube lighting with LED.*
14. Central heat pump ***(to replace primary ducted electric resistance FAU and AC combo)*** *Heat pump must be a minimum 15 SEER/8.2 HSPF (or equivalent SEER2/HSPF2) and include an EC air handler motor.* *California equivalent SEER/HSPF are 14.3 SEER2/7.5 HSPF2 (split-system), 13.4 SEER2/6.7 HSPF2 (package unit)*
15. Mini-split heat pump ***(to replace primary non-ducted electric resistance heat and non-ducted AC)*** *Mini-split heat pump must be minimum 19 SEER/10 HSPF.*
16. Central heat pump ***(to replace primary central heat pump manufactured pre-2006)*** *Heat pump must be a minimum 15 SEER/8.2 HSPF (or equivalent SEER2/HSPF2) and include an EC air handler motor.* *California equivalent SEER/HSPF are 14.3 SEER2/7.5 HSPF2 (split-system), 13.4 SEER2/6.7 HSPF2 (package unit)*
17. Window/wall AC ***(primary and manufactured pre-2014)*** *Replacement window/wall AC must be minimum 12 CEER or higher and of the same or lesser BTU capacity.*

13. CONVERSION TABLES FOR SEER2, EER2, AND HSPF2

13.1 If an appliance efficiency is not listed below that is needed, contact the CSD Technical Hotline at Wx.Hotline@csd.ca.gov.

13.2. Split System Air Conditioners

TABLE D-27: SPLIT SYSTEM AIR CONDITIONER, **<45,000 BTU/HOUR**

SEER2	SEER	EER2	EER
12.4	13.0	11.2	11.7
13.3	14.0	11.5	12.0
14.3	15.0	11.7	12.2
15.3	16.0	11.9	12.4
16.2	17.0	12.1	12.6
17.2	18.0	12.3	12.8
18.1	19.0	12.5	13.0
19.1	20.0	12.7	13.2
20.0	21.0	12.8	13.4
21.0	22.0	13.0	13.6
21.9	23.0	13.2	13.8
22.9	24.0	13.4	14.0
23.8	25.0	13.6	14.2

TABLE D-28: SPLIT SYSTEM AIR CONDITIONER, **≥45,000 BTU/HOUR**

SEER2	SEER	EER2	EER
12.4	13.0	9.8	10.2
13.3	14.0	11.2	11.7
14.3	15.0	11.5	12.0
15.2	16.0	11.7	12.2
16.2	17.0	11.9	12.4
17.1	18.0	12.1	12.6
18.1	19.0	12.2	12.8
19.0	20.0	12.4	13.0
20.0	21.0	12.6	13.2
20.9	22.0	12.8	13.4
21.9	23.0	13.0	13.6
22.8	24.0	13.2	13.8
23.8	25.0	13.4	14.0

13.3. Split System Heat Pumps

Table D-29: Split System Heat Pump

SEER2	SEER	HSPF2	HSPF
12.4	13.0	7.5	8.8
13.3	14.0	7.7	9.0
14.3	15.0	7.8	9.2
15.3	16.0	8.0	9.4
16.2	17.0	8.2	9.6
17.2	18.0	8.4	9.8
18.1	19.0	8.5	10.0
19.1	20.0	8.7	10.2
20.0	21.0	8.9	10.4
21.0	22.0	9.0	10.6
21.9	23.0	9.2	10.8
22.9	24.0	9.4	11.0
23.8	25.0	9.5	11.2

13.4. Packaged Air Conditioners and Packaged Heat Pumps

Table D-30: Packaged Air Conditioner and Packaged Heat Pump

SEER2	SEER	EER2	EER	HSPF2	HSPF
12.4	13.0	10.6	11.0	6.8	8.0
13.4	14.0	10.8	11.2	7.5	8.8
14.4	15.0	11.0	11.4	7.7	9.0
15.3	16.0	11.8	12.2	7.8	9.2
16.3	17.0	11.9	12.4	8.0	9.4
17.2	18.0	12.1	12.6	8.2	9.6
18.2	19.0	12.3	12.8	8.3	9.8
19.1	20.0	12.5	13.0	8.5	10.0

14. LIHEAP ENERGY AUDIT PROTOCOL

14.1 The energy audit is a tool that CSD applies for certain measures in the Low Income Home Energy Assistance Program (LIHEAP). Measures that require an energy audit are defined by the measure matrix for the LIHEAP contract, and are generally the same or similar to the measures defined for the DOE WAP.

14.2. LIHEAP Approved Measures

14.2.1 All measures to be installed with LIHEAP funds must comply with the installation requirements and materials specifications identified in the most recent copy of CSD's TRM. Approved measures for the program are defined by CSD's contract measure matrix, which is located on the CSD Providers' website. Measure categories for LIHEAP include those provided in Table D-27 through D-30.

Table D-31: LIHEAP Health & Safety Measures

Health & Safety Measures
Carbon monoxide alarm
Cooking appliance repair (range, cooktop, built-in oven)
Cooking appliance replacement (range, cooktop, built-in oven)
Cooling repair
Cooling replacement
CVA venting
Environmental hazard work/lead-safe
Heating source repair
Heating source replacement
Smoke alarm
Water heater repair
Water heater replacement

Table D-32: LIHEAP Mandatory Measures

Mandatory Measures	
Attic ventilation	Hardwired sconce fixture
Ceiling insulation	LED night-light
Door repair/replacement	LED torchiere lamp
Door, sliding glass	LED replacement bulbs
Duct insulation	LED tube lighting
Duct repair, sealing, and replacement	Limited home repair
ECM blower motor	Low-flow toilet
Efficient fan controller	Mechanical ventilation (if MV assessment is required by blower door diagnostics)
Filter replacement	
Faucet restrictor (aerator)	Microwave oven
Low-flow showerhead	Refrigerator replacement
Infiltration reduction measures (excludes door & window repair/replacement)	Thermostat-manual
Kitchen exhaust repair and replacement	Thermostat-programmable
Knee wall insulation	Thermostat-smart
LED downlight retrofit kits	Water heater insulation
Hardwired porch light fixture	Water heater pipe insulation

Table D-32: LIHEAP Mandatory Measures

Mandatory Measures	
Hardwired security fixture	Whole house fan
Hardwired ceiling fixture	Window repair/replacement (catastrophic)
Hardwired vanity fixture	Vacancy sensor switch

Table D-33: LIHEAP Optional Measures

LIHEAP Optional Measures	
Ceiling fans	Power strips, tier 2 advanced
Clothes dryer replacement	Shade screens
Clothes washer replacement	Storm windows
Dishwasher replacement	Thermostatic shower valve
Exterior water pipe wrap	Thermostatic showerhead
Floor foundation venting	Timer, electric water heater
Floor insulation	Tinted window film
Mechanical ventilation	Wall insulation

Table D-34: LIHEAP Optional–Audit Required Measures

LIHEAP Optional–Audit Required Measures	
Ceiling insulation (including attic ventilation, if needed)	Limited home repair (ECM support)
Cooling replacement (energy efficiency upgrade)	Refrigerator replacement
Duct insulation	Thermostat-programmable
Duct repair, sealing, and replacement	Thermostat-smart
Floor insulation (including crawlspace ventilation, if needed)	Wall insulation
Heating source replacement (energy efficiency upgrade)	Water heater installation (energy efficiency upgrade)
Infiltration reduction measures (excludes door & window repair/replacement)	Window replacement (energy efficiency upgrade)
Knee wall insulation	

14.3. LIHEAP Policies for Program Enrollment

14.3.1 The following policies for program enrollment and service shall apply to LIHEAP weatherization.

14.3.2 LIHEAP 66/50 Rule

14.3.2(a) A "whole-building approach" is encouraged:

14.3.2(a1) When 50% of the units in a duplex or four-plex are income-qualified for weatherization (or where a unit will be occupied by low-income tenants within 180 days under a federal, state, or local government rehabilitation program), the entire building may be served.

14.3.2(a2) When 66% of the units in a triplex or building with five or more are income-qualified, the entire building may be served.

14.3.2(b) If the 66/50 rule is met for income eligible units, investment for the whole building including any common area measures and in-unit measures within the building may not exceed the number of dwelling units times the current per-dwelling average maximum. This includes income eligible, non-income eligible, and vacant units. Completion of the CSD 75P form is required to show that the 66/50 rule is being applied correctly.

14.3.3 LIHEAP Whole-Building Weatherization

14.3.3(a) The following "whole building measures" listed below may only be considered for installation when an entire building will be served:

14.3.3(a1) Ceiling/knee wall insulation

14.3.3(a2) Common area measures: These measures must be cost-justified by energy audit and installed in common areas within the building thermal envelope of the qualified residential building).

14.3.3(a3) Cooling system energy efficiency upgrade (for a whole-building, common system)

14.3.3(a4) Floor insulation

14.3.3(a5) Heating system energy efficiency upgrade (for a whole-building, common system)

14.3.3(a6) Wall insulation

14.3.3(a7) Water heater energy efficiency upgrade (for a whole-building, common system)

14.3.3(a8) Windows for energy efficiency upgrade

14.3.3(b) For attic/ceiling and floor insulation, individual unit installation is allowed under LIHEAP for a duplex, tri-plex, or four-plex when:

14.3.3(b1) An energy audit will not be conducted,

14.3.3(b2) There is no shared attic space/crawlspace between the dwelling units (i.e., the attic spaces are separated by a complete and continuous pressure boundary or firewall), and

14.3.3(b3) The units to be served have separate heating and/or cooling units.

14.3.4 LIHEAP Individual Unit Weatherization

14.3.4(a) CSD has established a policy for weatherizing single-family and multi-family buildings that views the entire building as a complete system of interconnected dwellings and systems. In order to provide maximum energy savings and benefits to the residents of a building, a "whole-building approach" is preferred.

14.3.4(b) Although whole-building weatherization is preferred and encouraged, individual unit weatherization is allowed when as long as the reasons that whole-building weatherization is not feasible are thoroughly documented. With the Individual Unit approach, however, measures designed to be installed in the entire building (see LIHEAP Whole-Building Weatherization)are not eligible when only an individual unit is served. Note: Appliance repairs/replacements for Health & Safety as defined by CSD are not considered whole-building measures.

14.3.5 LIHEAP Vacant and Over-Income Unit Rule

14.3.5(a) When vacant or over-income units are encountered, the procedures in Vacant and Over-Income Rule shall be followed.

14.4. LIHEAP Audit Methodology

14.4.1 LIHEAP shares the energy efficiency goals of the DOE WAP, however there is some programmatic flexibility to address issues of occupant comfort, address crisis situations in households, and provide measures under multiple categories to simplify installation. CSD utilizes the same Technical Reference Manual for the installation requirements of both programs.

14.4.2 In LIHEAP, an energy audit can be conducted at the discretion of the agency if seeking to make improvements for energy efficiency upgrades. Some measures within LIHEAP that can be audited as an energy efficiency upgrade may also be installed prescriptively without the requirement to conduct an audit. An energy audit is required when any measure from the “Optional—Audit Required” category will be billed to that category. When none of the measures in the category will be installed, an energy audit is not required. Agencies are strongly encouraged to perform an energy audit for energy efficiency upgrades and whole building weatherization.

14.4.3 When an energy audit will be conducted for LIHEAP, the following policies from this document shall apply:

14.4.3(a) Developing an Audit Work Scope
14.4.3(b) ADM Cost Calculations
14.4.3(c) Interactive Effects for Energy Audits
14.4.3(d) Justification Image Requirements for REM/Design Energy Audits
14.4.3(e) Incidental and Ancillary Costs in the Audit Path
14.4.3(f) Additional Audit Path Considerations
14.4.3(g) Audit Path Installation Order
14.4.3(h) REM/DESIGN Energy Audit Procedure
14.4.3(i) Energy Audit Restrictions
14.4.3(j) REM/Design On-Site Visit
14.4.3(k) Energy Modeling and Analysis Process
14.4.3(l) REM/Design & Building Model True-up with Actual Energy Bills
14.4.3(m) REM/Design Reports
14.4.3(n) Quality Assurance Review—REM/Design Audits

14.5. LIHEAP Quality Assurance Review Process

14.5.1 The process for quality assurance review energy audits is the same as Quality Assurance Review—REM/Design Audits and Quality Assurance Review—TREAT Audits, however the step to submit the audit to the DOE project officer for approval is not required.

E. Health and Safety Requirements

Table of Contents

Health and Safety Requirements

1. INTRODUCTION

1.1 These Health and Safety Requirements provide policies and practices applicable to the weatherization programs administered by the California Department of Community Services and Development (CSD). These requirements apply to all agencies, subcontractors, and their field personnel who provide weatherization services.

2. PROGRAM GOAL

2.1 It is CSD's goal that its programs enhance clients' quality of life without creating an adverse condition in the home, and that work be conducted in a manner that protects the health and wellbeing of workers, occupants, and others who may be impacted (e.g., visitors, neighbors, pets, etc.).

2.2 Field personnel are to "do no harm" to residents and their property while working in each client's home. In addition, field personnel are to work in such a manner to protect their coworkers' safety. Safety decisions must take into consideration existing conditions, possible health effects that could be created by materials or activities at a jobsite, and potential hazards at agency/subcontractor offices, shops, and warehouses where preparatory weatherization activities take place.

2.3 Furthermore, it is not the goal of CSD's weatherization programs to bring all treated residences "up to code" or to fix all health and safety issues identified at the residence. Some conditions will be the sole responsibility of the property owner to correct. However, to protect occupants and workers, hazards and unsafe conditions affecting the health and safety of workers and/or occupants must be resolved whenever feasible and allowed by the program, before any program measures will be installed.

3. HEALTH AND SAFETY REGULATIONS

3.1 CSD weatherization agencies and their subcontractors must follow all applicable federal, state, and local health and safety laws and regulations pertaining to worker safety. Under California state law, worker safety is regulated by the:

- 3.1.1 California Occupational Safety and Health Administration (Cal/OSHA) General and Construction Safety Orders
- 3.1.2 California Code of Regulations (CCR)
- 3.1.3 California Department of Health Services—Health and Safety Code
- 3.1.4 California Labor Code (Department of Occupational Safety and Health)
- 3.1.5 Division of Occupational Safety and Health
- 3.1.6 California and national building codes (e.g., mechanical, electrical, and plumbing)
- 3.1.7 California Business and Professions Code
- 3.1.8 Department of Industrial Relations

3.2 Additional entities at the federal, state, and local level also may have jurisdiction over components of CSD's weatherization programs, and include, but are not limited to:

- 3.2.1 California Contractors State License Board
- 3.2.2 Environmental Protection Agency
- 3.2.3 California Environmental Protection Agency
- 3.2.4 Occupational Safety and Health Administration
- 3.2.5 Local Air Quality Management Districts

3.3 The CSD H&S Requirements do not supplant these federal, state, or local health and safety regulations. Rather, they are intended to supplement them, and provide clarification for Program interpretation.

3.4 All field personnel are required to follow CSD's health and safety requirements and their employer's (agency or subcontractor) internal health and safety policies to protect dwelling occupants, the individual worker, the crew, agency, and the program. Field personnel also are required to participate in scheduled safety trainings and meetings to reinforce safety practices in the shop and in the field.

4. CLIENT HEALTH AND SAFETY

4.1 Agency workers and subcontractors shall take all reasonable steps to "do no harm" to clients and their property. Before, during, and after all weatherization work, all field staff and subcontractors are required to identify and remedy (when within the program scope) potentially hazardous, unsafe, and unhealthy conditions that might affect clients during the weatherization process and use the least toxic materials feasible.

4.2 When the health and safety of the workers or residents may be jeopardized by the installation of a weatherization measure due to the presence of a hazardous condition, such measures shall not be installed until appropriate corrections have been made. When appropriate and feasible, minor repairs to correct hazardous conditions should be accomplished to eliminate hazardous materials or the threat to health and safety caused by their presence. While the program can remedy many unsafe and unhealthy conditions associated with the installation of measures, it does not have the resources to fix work outside of the program scope.

4.3 Assessors and crew members shall:

4.3.1 Thoroughly assess the condition of the dwelling, noting all potential safety hazards.

4.3.2 Conduct a weatherization assessment of each jobsite to identify existing and potential health and safety concerns.

4.3.3 Identify if a person's health condition is such that work activities would create a health or safety hazard for them. Occupants that may have health issues with the work being performed will be required to leave the home during these work activities.

4.3.4 Perform weatherization activities in a manner which:

4.3.4 (a) Ensures that client/occupants' and workers' health and safety is protected during all phases of the weatherization process; and

4.3.4 (b) Avoids subjecting the client/occupants to undue discomfort (e.g., blowing cold/damp air on frail or ill persons by pressurizing the home during winter).

4.3.5 Pay particular attention to elderly and disabled persons, and to young children who may be playing in areas where work is being done.

4.4 Note: If an H&S hazard exists prior to weatherization, installation of weatherization measures shall not proceed until such problems are remedied.

5. WORKER PROTECTION AND PERSONAL PROTECTIVE EQUIPMENT

5.1 All field personnel are required to wear appropriate gear to protect the worker while on the job, and to prevent the transfer of harmful materials from the jobsite to work vehicles and warehouses, and even home to workers' families. Careful selection of work clothing and personal protective equipment is the first step in protecting everyone.

5.1.1 Worker Clothing

5.1.1 (a) Loose or frayed clothing, dangling ties, chains and necklaces, bracelets, rings, etc. shall not be worn around moving machinery or other sources of entanglement. Appropriately safe footwear shall be worn, such as closed-toed work shoes or work boots suited to the task.

5.1.2 Personal Protective Equipment (PPE)

5.1.2 (a) In addition to proper work wear, when a hazard cannot be eliminated or controlled by work practices or other protections, workers also must use PPE (up to and including respirators) when applicable.

5.1.2 (b) Cal/OSHA requires that agencies/subcontractors conduct a hazard assessment at each job, and inform workers of the correct PPE that is required. The amount and type of PPE is determined by the level of assessed or presumed hazard, and based on the weatherization materials to be used.

5.2 Workers are required to wear PPE if instructed to by their employer. Employees can choose to wear PPE even if the hazard assessment shows that no exposure to a hazard will occur.

5.2.1 According to Cal/OSHA, workers are required to use PPE in these situations:

5.2.1 (a) Eye and face protection, when there is a risk of eye injury from flying particles, harmful chemicals, or harmful light rays.

5.2.1 (b) Foot protection, for workers who are exposed to foot injury from hot, corrosive, or harmful substances, from falling objects, or from crushing or penetrating actions.

5.2.1 (c) Hand protection, for workers who are exposed to cuts, burns, electrical current, or harmful physical or chemical agents. Hand protection includes durable and wrist-protecting gloves when needed to provide protection.

5.2.1 (d) Body protection, for workers who are exposed to harmful materials.

5.2.1 (e) Hearing protection, for construction work because noise levels often exceed 90 decibels.

5.2.1 (f) Head protection, for workers who could be exposed to flying or falling objects, electric shocks and burns, head injury from sharp objects such as protruding nails, or potential fall hazards.

6. GENERAL WORK SAFETY PRACTICES

6.1 Field workers must regularly assess workplace conditions and equipment before going to jobsites to ensure that correct tools and equipment are selected, and hazardous materials are stored properly.

6.1.1 Shop/Work Areas

6.1.1 (a) The shop and all work areas shall be free of obstacles and other hazards. The following precautions apply:

6.1.1 (b) Aisles and passageways shall be kept clear to allow for the safe movement of employees and material handling equipment.

6.1.1 (c) Stored materials must never block exits or fire doors.

6.1.1 (d) Combustible materials shall not be stored near combustion appliances, electrical outlets or circuit control panels.

6.1.1 (e) Lumber shall be stacked on level and solidly supported sills so that it is stable and self-supporting. Lumber piles that are handled manually shall be stacked no more than 6' high.

6.1.1(f) All scrap lumber, waste material, and work debris shall be removed from the immediate work area and be properly stored, recycled, or disposed of.

6.1.1(g) Tools and equipment shall be cleaned regularly and properly stored to prevent the transfer of particles and dust between jobsites.

6.1.1(h) Covers shall be provided for all containers used to store or transport oily or flammable chemicals and hazardous waste.

6.1.2 Work Vehicles

6.1.2(a) Agency crews and subcontractors are responsible for maintaining work vehicles in proper running order. All equipment, parts, and accessories that affect safe operation shall be checked regularly to assure that they are in proper working order and free from defects. Any vehicle that is unsafe shall be repaired before it is allowed in service.

6.1.2(a1) All seats in a vehicle shall be equipped with safety belts. Each operator and passenger riding in a vehicle shall occupy a standard seat (not a portable chair or other makeshift seat) and shall wear a safety belt.

6.1.2(a2) When performing service or repairs, employees shall not work under vehicles supported by jacks or chain hoists without protective blocking to prevent injury in case of mechanical failure.

6.1.3 Proposition 65 Materials

6.1.3(a) Proposition 65 (Prop 65), the Safe Drinking Water and Toxic Enforcement Act of 1986 requires the state to annually publish a list of chemicals known to cause cancer or birth defects or other reproductive harm, which is available at https://oehha.ca.gov/proposition-65/proposition-65-list. Compliance information is available from Cal/EPA's California Office of Environmental Health Hazard Assessment (OEHHA) at https://oehha.ca.gov/proposition-65.

6.1.3(b) Prop 65 mandates that a "clear and reasonable warning" be given to all individuals prior to exposure to chemicals on the list that can cause cancer, birth defects, or other reproductive harm. An agency and its subcontractors) may have one or more of the listed chemicals in the workplace as an ingredient in a material they use. If any materials are to be installed that contain chemicals that are Prop 65 listed, the agency/subcontractor must review the SDS with workers and provide a "warning" to the occupants before starting the job.

6.1.3(c) They must inform the homeowner of the presence of any listed chemicals (e.g., fiberglass insulation or solvents) before they are brought into a dwelling, unless the agency can prove that the exposure causes no significant risk.

6.1.3(d) The following chemicals/products are examples of some, but not all, listed chemicals that may be found on a weatherization worksite:

- Benzene (solvent)
- Butadiene (ABS, plastics)
- Carbon monoxide
- Ethyl chloride (in paints and similar products)
- Formaldehyde (in fiberglass insulation, particle board)
- Glass wool fibers (fiberglass)
- Lead-containing paint chips or dust
- Methyl chloride (in polystyrene foam, refrigerant)
- Methyl isobutyl ketone (solvent)
- Naphthalene (drywall)
- Toluene (solvents)
- Trichloroethylene (solvents, refrigerants)
- Urethane (insulations)
- Wood dust

6.1.4 Tools and Equipment

6.1.4(a) Agencies/subcontractors must provide workers with tools and equipment that are in good, safe-working condition and are ergonomically appropriate for the specific work task. When utilizing this equipment, workers shall:

6.1.4(a1) Check tools and equipment before each use to ensure that they are in good condition.

6.1.4(a2) Use hand tools only for their intended purpose.

6.1.4(a3) Avoid the use of materials and tools that are dull, bent, damaged, broken, have frayed or unsafe electrical cords (including cutting the ground lug off a 3-prong plug), etc.

6.1.4(a4) Use three-wire extension cords with all portable electrical tools, even if the tool has only two prongs and is internally insulated.

6.1.4(a5) Frequently inspect power tools, and use them only in accordance with manufacturer specifications to eliminate misuse of power tools, excessive noise, and improper or defective cords or extension cords.

6.1.4(a6) Verify that all electrical devices used are GFCI protected or double insulated.

6.1.4(a7) Connect metal insulation fill tubes to a grounding wire.

6.1.4(a8) Prevent exhaust gases from compressors and generators from entering living space.

6.1.5 Ladder Safety

6.1.5(a) Many workplace injuries or deaths could be avoided if proper ladder safety procedures were followed. Cal/OSHA mandates in Title 8, Section 3203 and subsection 3276(f) that all employees and supervisors who will use a ladder must be provided training unless the agency/subcontractor can prove that they have already been trained in ladder safety.

6.1.5(b) The following questions will be employed to ensure each worker knows how to properly use a ladder:

6.1.5(b1) **The Right Ladder for The Job.** An American National Standards Institute (ANSI) rating sticker should be on every ladder stating the ladder use and weight restrictions. Ensure that the ladder will hold the weight of the user and equipment. Avoid using metal ladders when performing electrical work.

6.1.5(b2) **Inspection.** Is a ladder in good condition? Are there any missing screws or bolts? Are there any loose pieces? Never use a damaged ladder.

6.1.5(b3) **Ladder Set Up.** The base of a ladder should be 1' from the building (or top support, such as an eave) for every 4' of ladder length up to the resting position. If a ladder square is on the side of the ladder, make sure it is parallel to both the ground and the vertical surface. If a stepladder is used, ensure braces are locked.

6.1.5(b4) **Ladder Location.** Is it safe to get on the ladder where it is located? If the work is outdoors, is it windy? Is the ground solid? Are there any power lines? Will the ladder be a hazard to another worker? What other hazards are nearby?

6.1.5(b5) **Climbing a Ladder.** Do not climb a ladder carrying tools or equipment. Hands (and feet) should be free of impediments. Workers must keep at least “three points of contact” until on the ground again.

6.1.5(b6) **Reaching.** Many accidents happen on ladders because the worker is reaching for something and loses balance.

7. JOBSITE SAFETY REQUIREMENTS

7.1 Workers are required to assess each jobsite and be vigilant about protecting their own, and their coworkers’ safety. Common on-site safety precautions are described below.

7.1.1 Dangerous Jobsite Areas

7.1.1(a) Workers shall use care when working in unsafe or potentially dangerous locations, including areas that may be contaminated by a pollutant or be structurally unsafe. Standard precautions include the following:

7.1.1(a1) Utilize adequate ventilation in work areas where gas-powered equipment is used.

7.1.1(a2) Wear appropriate PPE during all phases of work (assessment through inspection).

7.1.1(a3) Avoid entry into unsafe structures.

7.1.1(a4) Use walk/crawl boards when working in attics and crawlspaces to prevent falls and facilitate worker removal if necessary.

7.2 Clients must be informed of identified contaminants found during assessment (e.g., sewage, dead animals, needles, hazardous material, etc.) in work areas. The Deferral and Referral Policy shall be followed.

7.3 The appropriate local service agency (i.e., health department, animal control service, licensed clean-up or abatement contractor, etc.) must correct, repair, or remove the contaminant source before weatherization personnel can perform any work that requires access to the affected areas. When appropriate, contaminants shall be neutralized and/or a protective barrier shall be installed around the area.

7.4 Clients also must be informed that the client's clean-up of an area will not be considered acceptable for the removal of hazardous materials (such as asbestos, lead, or radon). Such removals must be performed and documented by a licensed abatement contractor for weatherization work to become feasible.

7.5. Drinking Water

7.5.1 A supply of potable water (safe to drink) shall be provided in all places of employment. Portable drinking water containers shall be equipped with a tap and tightly closing lid. Common drinking cups are not allowed.

7.6. First Aid Kit and Emergency Aid Information

7.6.1 Each agency/subcontractor(s) shall supply a Cal/OSHA-approved first aid kit for each work vehicle so they are readily available. A list of telephone numbers of physicians, hospitals, and ambulances must also be present in these kits in case of emergency. These kits should be updated and restocked regularly.

7.6.2 When possible, each crew should have available at least one person who is trained to render first aid, including CPR.

7.7. Heat Stress/Heat Stroke Prevention

7.7.1 Workplace temperatures (especially in attics and near roofs) may exceed what is safe for workers on certain days and in some climate zones. Temperature levels and the proper ventilation should be assessed before starting a job. In addition, these recommendations should be followed:

7.7.1(a) Adequate shade, water, and breaks shall be made available on hot days.

7.7.1(b) Crews should watch coworkers for signs of heat stress and help them to cool down.

7.7.1(c) If temperatures are unsafe, reschedule job to early morning or a different day.

7.7.1(d) Workers must heed all safety warnings from co-workers and supervisors.

7.7.1(e) If necessary, call 911 and request emergency assistance.

7.7.1(f) Prevent heat related illnesses by not allowing work where temperatures exceed 115ºF. Inside the attic space temperatures can exceed 150ºF on hot, sunny days and lung stress from hot air starts over 115ºF.

7.8. Slips, Trips, and Falls

7.8.1 Field personnel shall:

7.8.1(a) Use caution around power cords, hoses, tarps, and plastic sheeting.

7.8.1(b) Take precautions when ladders are used, when working at heights, or when balancing on joists.

7.8.1(c) Use walk boards when practical.

7.8.1(d) Wear appropriate footwear and clothing at all times.

7.8.1(e) Cal/OSHA regulations for fall protection shall be followed for work conducted on rooftops.

7.9. Material Safety

7.9.1 Agencies/subcontractors must ensure that materials handled by employees and installed in residences are safe for workers and occupants, and can be handled safely by workers.

7.9.1 (a) When selecting materials, the least toxic suitable material shall be chosen.

7.9.1 (b) Workers must handle hazardous materials in accordance with manufacturer specifications or Safety Data Sheets (SDS) instructions. When allowed by the program, workers will safely eliminate hazardous materials such as volatile organic compounds (VOCs), sealants, insulation, contaminated drywall, dust, foams, presumed lead, mercury, and fibers.

7.9.1 (c) A complete set of Safety Data Sheets (SDS) for all materials used must be on-hand at the worksite and in all work vehicles for every material used by field personnel. Similarly, warehouses and shops also must have a complete set of SDS on site for the materials used or stored.

8. JOBSITE SAFETY ASSESSMENT

8.1 The dwelling assessment must include a client or occupant health and safety analysis. Assessors must consider how these factors may affect the feasibility of measures:

8.1.1 Age and general health of the occupants, especially for more vulnerable populations (very young, disabled, seniors, etc.).

8.1.2 Possible effects of weatherization on the living space. Occupants with certain health issues may prefer to leave the home during work activities.

8.2 In assessing the jobsite, assessors and crew members also shall examine these additional dwelling conditions that may affect work, including but not limited to:

8.2.1 Neighborhood security

8.2.2 Household pets

8.2.3 Broken glass in work areas

8.2.4 Low electrical lines and other electrical hazards

8.2.5 Trash and debris

8.2.6 Tripping hazards in the work area (e.g., toys, furniture, tools on the ground, holes in the yard, etc.)

8.2.7 Insect activity (spiders, wasps, bees, etc.)

8.2.8 Interior safety conditions of the dwelling, noting all potential safety hazards including structural hazards, and conditions in the attic and crawlspace.

8.2.9 Identification of all elderly or disabled occupants, and young children, who may require entry to areas where work will be done.

8.3 (DOE only) The results of the assessment shall require:

8.3.1 The client to be informed in writing of any hazards associated with hazardous waste materials identified/being generated or handled in the home.

8.3.2 Observed hazardous condition and associated risks, particularly if air sealing would be performed.

8.3.2 (a) Provide the client with written materials on safety issues and proper disposal of household pollutants.

8.3.3 The client to be informed in writing of observed hazards and associated risks utilizing the CSD 540G DOE Health and Safety Form, if identified hazardous conditions will not be corrected during weatherization.

8.4 Precautionary Measures (DOE Only)

8.4.1 When the following measures are feasible, these Limited Home Repair - H&S Support measures shall be installed in conformance with Section 1 General Installation Guidelines.

8.4.1(a) Exposed earthen floors in basements and crawlspaces within the thermal/pressure boundary shall be covered and sealed with a soil gas retarder.

8.4.1(b) Installation of an airtight sump pump/well pit cover within the thermal/pressure boundary

9. IDENTIFICATION OF HEALTH AND SAFETY (H&S) MEASURES

9.1 H&S measures are a special category of weatherization measures that are installed to protect occupants, mitigate health and safety hazards related to certain appliances, and preserve or improve indoor air quality. H&S measures that are feasible must be identified during assessment so that H&S issues are prioritized before other measure categories. For DOE jobs only, feasible H&S measures cannot be removed from the work scope (for client refusal or other reason), or the dwelling shall be deferred.

9.2. Safety Devices

9.2.1 Safety devices (i.e., carbon monoxide [CO] alarms [Section 2 Carbon Monoxide Alarms] and smoke alarms [Section 3 Smoke Alarms]) are required health and safety costs in accordance with the feasibility criteria for those measures. When feasible, they shall be installed. If these measures are refused, the dwelling may be served under LIHEAP only.

9.3. Identification of Appliance Issues

9.3.1 Before any H&S appliance (heating, cooling, or water heating) may be repaired/replaced, a qualified technician/licensed contractor must perform a diagnostic inspection to determine if the appliance is defective or requires repair. It shall be determined if a cleaning and adjustment (appliance maintenance) would resolve an appliance performance or health and safety issue before the appliance is repaired or replaced.

9.3.2 Documentation justifying any appliance replacement with a cost comparison between replacement and repair must be maintained in the client file.

9.3.3 Heat Source Repair/Replacement

9.3.3(a) Replace, repair, or install primary heating systems when the existing primary heating system is unsafe, inoperable, or nonexistent. No home may be left without a safe primary heating system. If unable to meet this requirement, deferral is required.

9.3.3(b) Primary heat sources may include central forced air furnaces (FAU), wall, floor, freestanding furnaces, and wood-burning appliances.

9.3.3(c) For LIHEAP jobs

9.3.3(c1) Primary heat sources may be repaired or replaced when they meet the feasibility criteria identified in Section 4 Heating and Cooling. An appliance shall be replaced when the cost of repairs is greater than 50% of the replacement cost.

9.3.3(d) For DOE jobs

9.3.3(d1) A “red tagged,” inoperable, or non-existent primary heating system must be repaired, replaced, or installed.

9.3.3(d2) Perform a full DOE-approved energy audit prior to deciding how to categorize the cost of heating/cooling system repair or replacement. If the measure is an approved WAP expenditure and the audit justifies the costs with a Savings to Investment (SIR) ≥1.0, the measure must be installed as an Energy Efficiency Upgrade.

9.3.3(d3) If the measure is not an eligible ECM, replacement as a Health and Safety measure is allowed if the feasibility criterion in Section 4 Heating and Cooling is met.

9.3.3(d4) If the dwelling has an unvented combustion space heater as the primary heat source, it must be replaced with a vented unit or the dwelling will be deferred. The replacement unit must be sized to heat the entire dwelling.

9.3.3(d5) Unsafe secondary heat sources, including portable space heaters, must be repaired, or removed and disposed of, or dwelling deferral is required. A secondary unvented space heater is considered unsafe if it:

- Is not listed and labeled as meeting ANSI Z21.11.2
- Has an input rating of more than 40,000 BTU/hour
- Is in a bedroom and have an input rating of more than 10,000 BTU/hour
- Is in a bathroom and have an input rating of more than 6,000 BTU/hour
- Operates in an unsafe manner (e.g., high carbon monoxide (CO) readings, too close to combustible materials, lack sufficient combustion air volume, etc.)
- Is not permitted by the Authority Having Jurisdiction (AHJ)

9.3.3(d6) Heat sources in mobile homes must comply with the Manufactured Home Construction and Safety Standards, which mandate that:

- All primary and secondary appliances installed by or left in place after weatherization in manufactured homes must meet these standards. If a client will not allow removal of an unsafe combustion appliance from the home (primary or secondary), deferral is required.
- All fuel-burning appliances in manufactured homes except ranges, ovens, illuminating appliances, clothes dryers, solid fuel-burning fireplaces and solid fuel-burning stoves, must be installed to provide for the complete separation of the combustion system from the interior atmosphere of the manufactured home (i.e., to draw their combustion air from outside), and be vented to outside the dwelling.
- Repair or replacement of combustion gas venting shall be performed when necessary to ensure proper combustion gas venting to outside the dwelling for all combustion appliances, including but not limited to gas dryers and refrigerators, furnaces, vented space heaters, and water heaters.

9.3.4 Cooling Source Repair/Replacement

9.3.4(a) Replace, repair, or install a primary cooling system when the program policy is met.

9.3.4(b) Primary cooling sources may include central forced air furnaces (FAU), window/wall air conditioning, or evaporative cooling units.

9.3.4(c) For LIHEAP jobs

9.3.4(c1) Primary cooling sources may be repaired or replaced when they meet the feasibility criteria identified in Section 4 Heating and Cooling. An appliance shall be replaced when the cost of repairs is greater than 50% of the replacement cost. Primary cooling sources shall be replaced with a “like” type unless cost-justified by energy audit or approved by CSD waiver.

9.3.4(d) For DOE jobs

9.3.4(d1) Under DOE, when a H&S condition is identified for a primary cooling source, an energy audit is required. If the audit result is <1.0, the appliance may be repaired or replaced as a H&S measure only when an occupant in the household meets the “at-risk” definition below.

9.3.4(d2) To be considered at-risk, an occupant in the household must have a qualifying medical condition that requires temperature control. The condition must be verified by a doctor’s recommendation or other objective evidence gathered at the time of application.

9.3.4(d3) Documentation of the at-risk condition must be made on the agency-specific intake form and the CSD 540 Assessment Form. As part of the assessment, an assessor must evaluate the occupant’s general health.

9.3.5 Water Heating Repair/Replacement for H&S

9.3.5(a) Replacement, repair, or installation of a primary water heater type is permitted when an existing primary water heater is unsafe, inoperable, or nonexistent.

9.3.5(b) The appliance repair or replacement meets the appliance feasibility requirements in Section 13 Water Heaters—Gas, Electric, and Heat Pump.

9.3.5(c) Under DOE, when a H&S condition is identified for a primary water heater, an energy audit is required. If the audit result is <1.0, the appliance may be repaired or replaced as a H&S measure.

9.4. Portable Heating and Cooling

9.4.1 The SWEATS Program Temporary Appliances provision allows for portable heating or cooling appliances to be loaned when needed to maintain health, safety, and essential comfort level.

9.4.2 Equipment loans shall be provided on an interim basis until a permanent heating or cooling solution has been provided. Portable heating/cooling equipment includes:

9.4.2(a) Air conditioner

9.4.2(b) Evaporative cooler

9.4.2(c) Space heater

9.4.2(d) Room fan

9.4.3 Equipment loans shall be provided and documented in conformance with CSD's latest published SWEATS policy on the CSD Providers' website.

10. ENVIRONMENTAL HAZARD IDENTIFICATION AND NOTIFICATION

10.1 On the jobsite, all field personnel are asked to pay attention to their surroundings and look for signs of environmental hazards that may affect the health of occupants or safety of workers during the weatherization work. Some of these hazardous materials or conditions are correctable within the programs and some are not; but asking good questions of occupants and identifying these potential dangers could quickly save lives.

10.2 (DOE only) If one or more of the following environmental hazards in this section are identified during assessment, the client must be notified in writing.

10.2.1 Sources of potential asbestos or lead-based paint

10.2.2 Gas leak testing results with fuel leak sources and locations

10.2.3 Pests that would interfere with weatherization

10.2.4 Electrical hazards

10.2.5 Observed biological and unsanitary conditions

10.2.6 Structurally compromised areas

10.2.7 Code compliance issues which should result in deferral

10.2.8 Observed hazardous waste materials generated/handled in the home

10.3 Installation of weatherization measures affected by the observed hazard shall not proceed until the issue is mitigated or remedied by a licensed professional, when appropriate. Additional hazards may be identified that are not addressed in this section. For additional conditions, see Deferral and Referral Policy.

10.4. Asbestos

10.4.1 Asbestos is a fibrous mineral with fireproofing and insulation qualities and was used in a variety of building materials, including siding, walls, ceilings, vermiculite insulation, and in pipe, ducts, and furnaces, etc. In the1970s, it was discovered that asbestos fibers can cause asbestosis and lung cancer if inhaled. The inhalation risk is greatest when asbestos-containing construction materials are disturbed during remodeling activities and become “friable” (airborne).

10.4.2 The California Contractors State License Board (CSLB) advises that it can be assumed that asbestos is present in any structure built before 1980, unless there is proof that the materials are asbestos-free (such as by laboratory testing).

10.4.3 Common Asbestos-Containing Materials (or “ACMs") and their use in construction are shown in Table E-1.

TABLE E-1: ACM USES IN CONSTRUCTION

Asbestos-Containing Materials Used in Construction	Common Uses of ACMs in Older Homes
• Pipe and boiler insulation	• Duct insulation
• Asbestos insulation (powdered or in vermiculite)	• Duct sealing materials
	• Ducts made of ACM
• Plaster, cement, drywall, joint and taping compounds	• Walls and ceilings
	• Ceiling and wall insulation (e.g. vermiculite)
• Acoustical ceilings (tiles and sprayed-on)	• Textured ceiling (or “popcorn” type)
• Asbestos-cement piping, shingles, and panels	• Drywall and drywall compound
• Roofing felt and sealing compounds	• Caulking compound
• Floor tiles	• Siding
• Siding shingles	• Flues

10.4.4 All applicable Cal/OSHA regulations pertaining to asbestos and asbestos-containing materials shall be followed.

10.4.5 Field personnel are encouraged to learn to recognize ACMs and due diligence must be taken when working around building components that may contain ACM because weatherization personnel or appointed representatives may not take any action that will disturb, expose, release, or discharge any ACM. This includes (attempted) removal or disposal of any ACM/presumed-ACM during the installation of a weatherization measure.

10.4.6 See the Asbestos Policy for additional guidance and program requirements.

10.5. Biologicals

10.5.1 Biological health hazards are those that are caused by molds, viruses, bacteria, insects, rodents, and other animals. The remediation of these hazards or potential hazards is not a weatherization agency responsibility however, field personnel may encounter these conditions and must use appropriate safety equipment and PPE to protect themselves to the extent possible.

10.6. Viruses/Bacteria

10.6.1 Weatherization activities can cause the release of dust and other particles as workers move through a home. As a result, these viruses and bacteria may affect field workers and clients during and after weatherization:

10.6.1(a) **Hantavirus** comes from rodent feces, saliva, and urine. Working in attics or crawlspaces without respiratory equipment and not washing hands after touching infected rodent feces can transmit the disease to workers. Hantavirus is typically found in the eastern and western sides of the Sierras and desert areas. Agencies should check with the local public health departments to find out if Hantavirus has been detected locally, then educating and protecting workers as needed.

10.6.1(b) **Valley fever** is commonly found in the dry soils of the California Central Valley and in the southeastern part of the state. Outbreaks occur in Southern California after major earthquakes when soil is stirred up and the virus is made airborne. This virus is carried in dry soil, so workers in crawlspaces should wear adequate respiratory protection.

10.6.1(c) **Tuberculosis (TB)** is a major bacterial disease primarily affecting the lungs. The TB bacteria are spread through tiny droplets released into the air via coughing/sneezing. Field personnel should be cautious in households with respiratory illness and regular worker screening may prevent crew members from transmitting this disease.

10.6.1(d) **Rabies** is a preventable viral disease transmitted through the bite of a rabid animal. Each year, cases are documented in wild animals like raccoons, skunks, bats, and foxes, and more rarely in domesticated animals. A bite from any animal must be taken seriously and treated immediately. Owners must show proof that their pet was vaccinated if their pet bites someone. A bite by an unvaccinated pet or wild animal will require rabies treatment. Workers should not approach or contact any unfamiliar animal.

10.7. Pests/Poisonous Bites and Stings

10.7.1 There are many animals that can bite or sting, causing an allergic reaction or direct poisoning on the jobsite. A pest inventory should be undertaken before any work to identify potential hazards.

10.7.2 Insects that may cause structural damage are:

10.7.2(a) Termites

10.7.2(b) Powder-post beetles

10.7.2(c) Carpenter ants

10.7.3 Checks should also be made for pests that may endanger workers, such as:

10.7.3(a) Bees, wasps, scorpions, ticks, bedbugs, fleas, etc.

10.7.3(b) Spiders and snakes

10.7.3(c) Rats, mice, and other wild animals

10.7.4 If pests impede work, they should be removed safely (when possible) before work begins. Use caution with chemicals to kill bugs, as pesticides may cause more severe health hazards than the bugs they kill.

10.7.4(a) Workers who are allergic/reactive to stings should inform crew members and, if they have a sting kit, they should review its use with other crewmembers.

10.7.4(b) If a worker is bitten or stung, try to collect the bug that did it in case positive identification is required by a doctor.

10.7.5 If rodents or other wild animals are observed on the jobsite, dwelling deferral or measure deferral may be required until removal by a trained professional is possible. See the Deferral and Referral Policy.

10.8. Dwelling Structure Hazards

10.8.1 Dwellings shall be evaluated for any structural conditions that may jeopardize the safety of crews and occupants during or after weatherization. A thorough structural inspection shall include a check of:

10.8.1(a) Leaking and/or deteriorated roof or floors

10.8.1(b) Damaged or severely sagging surfaces and joists in the attic

10.8.1(c) Failed or sagging foundations, joists, or flooring

10.8.1(d) Damaged or deteriorated tub/shower or plumbing

10.8.1(e) Deteriorated siding, or door/window frames

10.8.1(f) Major HVAC defects that exceed the scope of the program.

10.8.1(g) Dwelling rehabilitation is in progress, client hoarding is present, etc.

10.8.2 Do not enter a crawl area (attic or crawlspace) affected by any of the following conditions:

10.8.2(a) Hazardous insect or rodent infestation

10.8.2(b) Excessive ground moisture (standing water, or mud)

10.8.2(c) Hazardous electrical condition

10.8.2(d) Sewage waste on the ground, or any other unsanitary condition

10.9. Combustion Gases

10.9.1 Carbon monoxide (CO) is a poisonous gas that can cause permanent brain damage or even death. It is colorless, odorless and tasteless therefore, workers must be aware of its sources and the signs of CO poisoning.

10.9.2 In any setting where a propane or natural gas appliance is in operation (office, shop, warehouse or weatherization client's home), there is the possibility of excessive CO in the air due to an appliance malfunction.

10.9.3 Personal CO monitors

10.9.3(a) In accordance with the Building Performance Institute (BPI) 1200 standard, and the Department of Energy application of that standard for Quality Control Inspectors, personal CO monitors ("dedicated ambient CO monitors) shall be worn by certified QCIs while in the work environment.

10.9.3(b) Within the confined spaces regulations, CalOSHA also may require the use of personal CO monitors for the safety of agency field personnel when performing work in attics, crawlspaces, or other locales meeting the confined spaces definitions. Requirements for this equipment are defined by CalOSHA Title 8, General Industry Safety Orders Section 5157.

10.9.4 Common signs of CO poisoning include the following:

10.9.4(a) Headache

10.9.4(b) Nausea

10.9.4(c) Sleepiness

10.9.4(d) Dizziness or fainting

10.9.4(e) Drunk feeling or foggy thinking

10.9.5 If CO poisoning of an occupant or worker is suspected, the affected person must be immediately provided with plenty of fresh air. If fainting occurs, cardiopulmonary resuscitation (CPR) may be required and qualified medical assistance should be obtained.

10.10. Combustion Safety Worker Requirements

10.10.5(a) All field personnel are required to follow the diagnostic testing and combustion safety protocols outlined in the Appendix A Combustion Appliance Safety Protocol to ensure the safe and proper operation of all combustion appliances at each jobsite. Combustion safety workers will:

10.10.5(a1) Identify fuel leaks around and in the building before starting combustion appliance testing. If fuel leaks are present, testing must be discontinued, and the condition shall be reported immediately to the occupant(s) and appropriate utility company.

- If extremely strong gas odors are present in the unit, call to notify the utility company from outside of the unit.

10.10.5(a2) Monitor ambient CO during combustion testing. Testing will be discontinued if ambient CO level inside the home or workspace exceeds 9 parts per million (ppm).

10.10.5(a3) Beware of flame roll-outs.

10.10.5(a4) When a hazardous condition appears to be present, the resident and owner/agent (if a rental) shall be notified and examination by a qualified professional is required.

10.10.5(a5) Combustion appliance testing shall dictate feasibility of infiltration-reduction measures.

10.10.5(a6) Identify sources of CO in the shop or warehouse. CO may be created by gasoline-powered equipment, such as compressors and generators. Such equipment shall be used only with adequate ventilation.

10.11. Confined Spaces

10.11.1 Cal/OSHA Confined Space standards protect employees from hazards related to confined space exposure.

10.11.2 Agencies and their subcontractors will be responsible for complying with all confined space requirements at each worksite. Information can be found on the Cal/OSHA website at https://www.dir.ca.gov/dosh/dosh_publications/ConfSpa.pdf. Applicable regulations include:

10.11.2(a) Cal/OSHA Title 8, Sections 1950-1962 set forth requirements for practices and procedures to protect employees engaged in construction activities at a worksite with one or more confined spaces. The standard is provided at https://www.dir.ca.gov/Title8Index/t8index.asp

10.11.2(b) Cal/OSHA Title 8, Section 5158 prescribes minimum standards for preventing employee exposure to dangerous air contamination, oxygen enrichment and/or oxygen deficiency in confined spaces. The standard is provided at https://www.dir.ca.gov/title8/5158.html

10.11.3 Employers are required to: 1) determine if there is a confined space, and if so, 2) evaluate the associated hazards and implement specific procedures to protect workers. The level of action is dependent upon whether the space is a “permit-required confined space” or “confined space” only.

10.11.3(a) A “confined space” is a space where:

10.11.3(a1) The space is big enough to enter but not intended for regular occupancy,

10.11.3(a2) There is limited access for entry/exit due to the location and/or size of the opening(s).

10.11.3(b) A “Permit-Required Confined Space” (PRCS) meets one or more of the following conditions:

10.11.3(b1) The space contains a hazardous or potentially hazardous atmosphere

10.11.3(b2) There is the potential for employee engulfment (e.g., by liquid, soil, etc.)

10.11.3(b3) The shape of the space could cause a worker to be trapped or smothered,

10.11.3(b4) Another serious safety or health hazard exists (e.g., unsafe temperature, electrical shock, corrosive or unsafe chemicals, etc.).

10.11.3(c) If a confined space does not have the potential to contain a hazardous atmosphere, it is defined as a Non-Permit Confined Space (NPCS).

10.11.4 Attics, chases, and crawlspaces may be either a PRCS or a NPCS; therefore, all Cal/OSHA confined space regulations to enter the space will apply. Confined spaces (attics, crawlspace) must be inspected for safety hazards prior to any work activity in the space.

10.12. Electrical Hazards

10.12.1 Electrical safety assessment will be performed at each jobsite and regularly at the agency's/subcontractor's warehouses and shops. When installing measures that increase the electrical load to any circuit, field personnel must consult the measure Technical Resource Manual (TRM) for required corrections and obey the requirements of the local jurisdiction (including acquisition of a permit, when required). Common hazards include:

10.12.1(a) Unsafe electrical wiring (e.g., frayed or missing insulation, bare wires, improperly secured splices, lack of junction boxes, etc.).

10.12.1(b) Proximity of water sources (e.g., condensate pans) to electrical sources.

10.12.1(c) Aluminum products (such as foils, etc.) near live wires.

10.12.1(d) Aluminum ladders used for electrical work.

10.12.1(e) For arc flash hazards, the National Electric Code standard (NFPA 70E) will be consulted.

10.12.1(f) Broken light fixtures, loose electrical fixture boxes

10.12.1(g) Damaged outlets and switches

10.12.1(h) Missing cover plates

10.12.1(i) Fire resulting from heat build-up due to encapsulation of electrical sources by insulation

10.12.1(j) Electrical cords/improper use of extension cords

10.12.1(j1) Improperly connected electrical appliances

10.12.1(j2) Workers shall not use electrical cords that are damaged, such as frayed or worn insulation or loose connectors.

10.12.1(j3) In all on-site work areas, all electrical cords shall be GFCI-protected.

10.12.1(k) Knob-and-tube (K&T) wiring

10.12.1(k1) Workers will avoid K&T wiring unless the wiring is certified to be safe by a licensed electrical contractor. (See Section 1 General Installation Guidelines, Knob-and-Tube (K&T) Wiring Guidelines.)

10.12.1(l) Aluminum wiring

10.12.1(l1) If aluminum wiring is present, work on the home must be stopped until the suspect wiring is inspected and determined to be safe by a licensed electrical contractor (C-10).

10.12.1(l2) After an energy retrofit is completed, wiring will be re-inspected by a C-10.

10.12.1(m) Mobile home additional policies

10.12.1(m1) When installing measures that increases load to any circuit, the mobile home metal skin and frame will be grounded through the panel box.

10.12.1(m2) The grounding system will be connected to a copper grounding rod that is driven into the ground a minimum of 8' when possible, and when required by code or the authority having jurisdiction.

10.13. Fire/Flammable Materials

10.13.1 To prevent against fire, field personnel shall:

10.13.1(a) Remove and block existing insulation where it covers heat-producing devices or combustion ventilation air vents.

10.13.1(b) Identify and eliminate potential ignition sources, where possible.

10.13.1(c) Use appropriate materials around heat producing devices or open flames.

10.13.1(d) Eliminate or reduce use of flammable materials.

10.13.2 Workers are never allowed to smoke at a jobsite.

10.13.3 Flammable materials stored near water heaters and furnaces shall be removed and stored in a safe place on the property. Occupants shall be made aware of the importance of keeping combustibles away from appliances.

10.13.4 Combustion and ventilation air (CVA) vents that are obstructed by household items shall be cleared, and occupants shall be made aware of the importance of clear vents.

10.14. Lead-Based Paint

10.14.1 According to CSD policy, when a home was built before 1978, the home shall be presumed to contain lead-based paint. (See Lead Safe Weatherization (LSW) Policy.) Age of the home must be determined by: statements from the county assessor's office, online fee-based verification services, title company documentation, etc.

10.14.2 Lead is a toxic metal that has been used in paint and many other products, and can also be found in dust where lead products are degrading. When any amount of lead enters the bloodstream, it can harm the body and brain, especially in children under six years old, in pregnant women, and in the elderly.

10.14.3 Symptoms of lower level lead poisoning may include stomachache, crankiness, headaches, and loss of appetite; however, it is important to know that some people show no outward signs. Higher levels of lead poisoning may lead to lifelong learning, behavioral, reproductive, cardiovascular, and other health problems. The only sure way to detect lead poisoning is with a blood test.

10.14.4 CSD does not allow lead abatement to be completed within the scope of weatherization.

10.14.5 In pre-1978 homes:

10.14.5(a) Lead-safe regulations and practices must be followed for the California Department of Public Health, Cal/OSHA, the Environmental Protection Agency (EPA) Renovation, Repair and Painting (RRP) Program, and the U.S. Department of Housing and Urban Development, as applicable.

10.14.5(b) Lead-safe weatherization (LSW) assessment, work, and inspection practices shall be employed in conformance with Lead Safe Weatherization (LSW) Policy.

10.14.5(c) When paint will be disturbed, the agency-assigned certified renovator must be on-site during the set-up, clean-up, and to conduct the clearance procedure.

10.15. Methane Gas

10.15.1 The smell of methane (or sewer gas) is usually a waste line and/or vent system which requires fixing or adjustment.

10.15.2 In more dangerous cases, it could be due to a ruptured or broken natural gas or propane line. If this is suspected, field personnel shall immediately aid occupants in leaving the dwelling and contact the gas service company for the dwelling.

10.15.3 If naturally occurring ground methane is detected, field personnel shall advise the occupant and homeowner/agent (if a rental) to contact the local health department or the Department of Agriculture Extension Service for further information and assistance.

10.16. Mold and Moisture

10.16.1 Dwellings shall be inspected for previous or existing moisture problems. Visual inspection shall be conducted to identify:

10.16.1(a) Water-stained ceilings and walls

10.16.1(b) Signs of leaks or mildew on the roof and attic structure

10.16.1(b1) A leaky, deteriorated roof must be fixed before attic-related work is conducted, and may be within the scope of the program to correct, if minor

10.16.1(c) Condensation or other water damage near doors, windows, and the adjacent walls

10.16.1(d) Moist floors or standing water in the crawlspace or basement, or watermarks on the walls

10.16.1(e) Leaking plumbing

10.16.1(f) Lack of air movement through the home

10.16.1(f1) Note: Rooms where registers and doors have been closed may develop moisture issues in cold weather. Educate clients about the need for air circulation to reduce the potential for mold and mildew.

10.16.1(g) Inadequate ventilation in the home

10.16.1(g1) High humidity levels in the dwelling

10.16.1(g2) Missing or malfunctioning local exhaust fan in the bathroom

10.16.1(g3) Missing or malfunctioning kitchen exhaust

10.16.1(g4) Clothes dryer without a moisture exhaust venting to outdoors

10.16.2 During the assessment process, field personnel shall report on noticeable signs of moisture/mold problems in the CSD 540A Wx Mold/Moisture Assessment and Release form.

10.16.3 When repairs are feasible, moisture problems shall be eliminated at the source. If a major leak is present, deferral is required and must be documented in accordance with the Deferral and Referral Policy.

10.16.4 If workers encounter moisture issues that were not identified during the dwelling assessment, they should stop work and contact their supervisor about next steps.

10.17. Plumbing Assessment

10.17.1 Review of the plumbing system shall be made prior to weatherization. When repairs are feasible, they shall be made and the affected area shall be allowed to dry completely before measures are installed.

10.17.1(a) Moisture from leaks in household plumbing fixtures and pipes resulting in mold/mildew growth and structure degradation shall be documented.

10.17.1(b) Sewer leaks, “gray water” leaks, or standing water can cause illness to workers and residents. The dwelling shall be deferred until issues can be corrected in accordance with the Deferral and Referral Policy.

10.18. Pesticides

10.18.1 If pesticides are present in a work area, field personnel shall wear properly-rated respirators and protective clothing.

10.19. Radon

10.19.1 Radon is a naturally occurring radioactive gas that is odorless, invisible, and without taste. It is released during the natural decay of uranium, which is present in some rock, soil and water.

10.19.2 Radon is the second leading cause of lung cancer in the United States, after cigarette smoking.

10.19.3 See Radon Policy. For more information, refer to https://www.cdph.ca.gov/Programs/CEH/DRSEM/Pages/EMB/Radon/Radon.aspx.

10.20. Unvented Space Heating

10.20.1 Unvented combustion appliances produce moisture as well as other indoor air contaminants. Primary unvented space heaters must be removed (with client permission) and replaced by a properly vented heat source.

10.20.1(a) Client refusal to allow removal of a primary unvented space heater will result in the home qualifying for non-infiltration reduction measures only (home is NIM).

10.20.2 When an unvented space heater is a secondary heat source, assessors should explain the potential dangers of use to the client and seek permission to remove the appliance if it is not ANSI Z21.11.1–listed.

10.20.2 (a) Client refusal to allow removal of a secondary unvented space heater shall be documented, but does not NIM the home. Other types of unvented combustion appliances (i.e., cooktops, ovens, etc.) are not covered by this mandate or by California's Title 24 codes.

10.21. Ventilation Measures and Indoor Air Quality (IAQ)

10.21.1 Many weatherization measures have the ability to improve indoor air quality:

10.21.1 (a) Sealing ducts eliminates the infusion of attic or crawlspace air into the conditioned space. See Section 8 Ducting Repair, Sealing and Insulation.

10.21.1 (b) Correcting non-conforming combustion appliance conditions eliminates toxic gases in the home

10.21.1 (c) Sealing thermal bypasses and infiltration locations reduces unconditioned or polluted air being drawn into a dwelling. See Section 32 Infiltration Reduction.

10.21.2 Some weatherization measures, such as infiltration-reduction, has the potential to worsen the quality of the indoor environment, because they seal in toxic air already present. Dwellings shall not be sealed when uncorrected environmental hazards are present.

10.21.3 The effect of a measure installation on IAQ should be considered before any measure is installed. Caution should be taken when conducting air sealing in dwellings where air quality is a concern.

10.21.4 Each dwelling must be evaluated to determine if the installation of a controlled air source (mechanical ventilation [Section 12 Mechanical Ventilation] and/or a kitchen exhaust [Section 11 Kitchen Exhaust]) would improve the air quality, or if its installation would potentially worsen the health condition of occupants.

10.22. Volatile Organic Compounds (VOCs)

10.22.1 Formaldehyde vapors may be slowly released by some new carpets, particle board, waferboard, plywood, etc., which is known as "off-gassing". Other types of VOCs are also emitted by some household cleaning agents and paints.

10.22.2 Caution should be taken when measuring and setting tightness limits in dwellings with VOCs present. The client shall be notified and asked to remove stored containers of chemicals, when feasible.

10.22.3 If a client is physically unable to remove the chemicals, assistance shall be provided to move the containers to a safe outdoor storage location.

10.23. Task-Oriented Worker Safety

10.23.1 Field personnel are required to incorporate safe work practices in every aspect of the workday. Certain specialty tasks have additional worker safety policies that are summarized in Table E-2.

TABLE E-2: SPECIALTY JOB REQUIRED SAFETY PRACTICES

Job Role	Job Requirement
Air Sealing Worker Safety	• Workers performing air sealing of a structure shall have access to all parts of the structure. Some materials may require the use of special respirators. • Workers and supervisors shall ensure that the following are included as safety practices with air sealing jobs: − Confirm structurally sound ceiling and roofing, safe placement of walk boards, and safe electrical wiring and boxes are in place. − Identify existing insulation types to ensure that hazardous insulation materials like asbestos and vermiculite are not present. − Ensure adequate ventilation and accessibility in attics and crawlspaces. Crews shall practice safety drills in case of accidents in a tight attic or crawlspaces. − Use respirators with HEPA/N-100 filters to prevent the inhalation of particulates—attic/crawlspace dust, mold spores, animal feces, insulation fibers, etc. − Use hard hats to prevent head injuries. − Thoroughly review and follow Safety Data Sheets for all air sealing materials used. − Postpone crawlspace (e.g., sealing and insulation) until after any feasible appliance and HVAC system work has been completed and inspected.
Baseload Worker Safety	• Gas and electric baseload workers shall be aware of safety practices for the following: − Electrical and natural gas hazards − Lifting hazards
Basement and Crawlspace Worker Safety	• Workers entering basements and crawlspaces shall identify, document, and avoid the following safety hazards: − Accessibility in tight places − Pooled water or sewage − Insect and animal hazards − Environmental hazard sources, drug paraphernalia, animal waste, etc. • A negative pressure will be maintained in the crawlspace with reference to the house while work is being performed in the crawlspace. • Appropriate PPE shall be used when working in basements and crawlspaces
Ventilation Worker Safety	• Ventilation workers will be aware of electrical hazards when installing ventilation systems or controls in addition to general safety practices.

TABLE E-2: SPECIALTY JOB REQUIRED SAFETY PRACTICES

Job Role	Job Requirement
Heating and Cooling System Worker Safety	• Workers shall be aware of tasks that may expose workers to a variety of safety hazards. Workers should be aware of: – Structural issues, if roofs are accessed – PPE appropriate for heating and cooling tasks – Need for long sleeves and long pants as additional protection – Liquid nitrogen and other hazards. – Asbestos-containing materials in or on duct systems – Mercury bulbs in thermostats (dispose of in accordance with EPA guidance). – Proper refrigerant recovery procedures and safety equipment – The presence of combustible gas leaks ▪ Leaks must be repaired before work is performed. – The presence of ambient CO before and during work. ▪ CO issues must be addressed before weatherization work is performed or continued. – Pipes needing to be sealed by a certified professional in accordance with manufacturer specifications – Shut-off valves needing to be installed by a certified professional at each gas appliance (in accordance with ANSI Z21.15)
Refrigerant Worker Safety	• Certified technician shall reclaim refrigerant in accordance with the Clean Air Act 1990, section 608, as amended by 40 CFR 82, 5/14/93. • Agencies/subcontractors shall ensure that they have appropriate protocols in place that comply with all standards relating to the disposal of the existing appliances. • A written record/description of hazardous materials encountered which required special handling and/or disposal shall be kept in the client's permanent file.
Clean-up Worker Safety	• Field personnel shall maintain clean and safe working conditions on the job as required by Cal/OSHA Construction Safety Orders. Workers performing clean-up functions shall use a HEPA vacuum to clean up dust and debris. • Appropriate means for containment and disposal of waste materials and debris shall be used. Workers shall leave the dwelling and premises in a condition that is as good as or better than it was prior to commencement of work.

11. ENVIRONMENTAL HAZARD POLICIES

11.1. General Policy for Environmental Hazard Resolution

11.1.1 Limited removal of pollutants that pose a risk to workers is required where possible (e.g., flammable liquids, hazardous chemicals, and other air pollutants) as defined in this section.

11.1.1 (a) If removal cannot be performed or is not allowed by the occupant, the unit must be deferred.

11.1.2 Removal of certain types of biologicals and environmental hazards (e.g., mold, odors, viruses, bacteria, raw sewage, dead animals, etc.) is not allowed within CSD's weatherization programs; however, weatherization workers frequently encounter these conditions.

11.1.3 If one or more of these conditions is identified, and if the problem is not corrected by the homeowner (or a licensed abatement contractor for substances such as lead, radon, asbestos, etc.), weatherization services shall be deferred (using the CSD 542 Weatherization Deferral form). If available, agencies shall refer the client to another agency for assistance and remedial action (rehabilitation).

11.2. Agency/Subcontractor Oversight Responsibilities for Environmental Hazards

11.2.1 Weatherization agencies and subcontractors are advised to proceed cautiously when preparing to weatherize a dwelling unit where environmental hazards may be present.

11.2.2 Work must be performed in accordance with guidelines set forth by the Contractors State License Board (CSLB), Cal/OSHA, the Environmental Protection Agency (EPA), and other regulatory entities.

11.2.3 When toxic or potentially toxic materials and/or conditions are known to be present, agencies are advised to inform the building owner and to create a work scope that ensures weatherization will not cause harm to occupants or installers. Where work cannot be performed safely, the dwelling must be deferred until hazardous conditions are resolved. Furthermore:

11.2.3(a) All agencies/subcontractors providing work under the CSD weatherization programs shall be knowledgeable regarding the laws pertaining to construction activities involving the specific environmental hazard identified.

11.2.3(b) Agencies/subcontractors are responsible for providing health and safety training for their field personnel.

11.2.3(c) Agencies/subcontractors may not use abatement contractors to remove or dispose of hazardous materials without prior authorization from CSD.

11.2.3(d) Hazard remediation costs shall not be allowed under CSD programs however, testing may be allowed when allowed by state and federal regulations.

11.2.3(e) No action may be taken that will disturb, expose, release, or discharge any presumed hazardous material for testing. Only properly trained personnel may remove samples of material for laboratory testing to determine if the sample is, in fact, hazardous.

11.2.3(f) Where the presence of a hazardous material is known or suspected, appropriate safety practices shall be followed to minimize exposure to environmental hazards. Installers shall be required to use safe work practices.

11.2.3(g) Work around hazardous materials shall conform with state regulations, which may include required trainings, use of properly-rated respirators and protective clothing, containment when needed, proper laundering of clothing, and other specified practices.

11.2.3(h) Respirators with appropriate filter cartridges must be worn when working in areas where exposure to airborne environmental hazards is a risk. Before issuing respirators, workers must be medically assessed to make sure they can wear a respirator without causing breathing problems, fit tested for the respirator type, and trained in the proper care and usage of respirators.

11.2.3(i) When a hazardous material is suspected, the agency/subcontractor shall inform the property owner and describe the precautions that will be taken to eliminate exposure in writing. Additionally, agencies and their subcontractors shall:

11.2.3(i1) Instruct occupant(s) to avoid and not disturb confirmed hazardous material locations

11.2.3(i2) Formally notify occupant(s) when test results are positive for the hazardous material (if testing is performed), and obtain a client signature confirming receipt of notification

11.2.3(i3) Provide safety information to the client, when available

11.2.3(j) Occupants will be asked to contract with an EPA-certified contractor to conduct abatement before weatherization is performed in the affected area (occupant is responsible for abatement or remediation work and costs). A clearance report for the removal of the material must be received by the agency before weatherization work is resumed.

11.3. Deferral and Referral Policy

11.3.1 Conditions may exist that cannot be mitigated because corrections exceed the scope of the CSD weatherization programs or cannot be achieved in a cost-effective manner. In these instances, agencies shall install feasible measures and, as applicable, refer the client to other agencies/ programs, such as the following, for additional assistance:

11.3.1(a) U.S. Farmers Home Administration (FHA) Housing Loan Program

11.3.1(b) U.S. Department of Housing and Urban Development (HUD)

11.3.1(c) Department of Housing and Community Development (HCD)

11.3.1(d) County Department of Aging or Senior Resources

11.3.1(e) Other similar programs

11.3.2 When work is not feasible due to an identified deferral condition, or until the client corrects an existing condition, the CSD 542 Weatherization Deferral form shall identify and describe the condition(s) causing the delay, including what work will be done, by whom, and with client and assessor signatures. Weatherization activities may take place after the repairs are complete.

11.3.3 Client refusal of a diagnostic test will be documented on the CSD 542 Weatherization Deferral, and on the appropriate diagnostic form.

11.3.4 Note: The CSD 540 Dwelling Assessment form is used to document a client's refusal of a measure.

11.3.5 Client Notification of Deferral

11.3.5(a) The client shall receive written notification (a copy of the CSD 542 Weatherization Deferral form) of the issue and a description of what the property owner can do to facilitate installation of deferred weatherization measures. When the property is a rental, written notification shall also be provided to the homeowner/agent.

11.3.5(b) Prior to obtaining client signature(s) on the deferral form, weatherization personnel shall:

11.3.5(b1) Review the contents of the form with the client and explain each applicable section.

11.3.5(b2) Ensure that the client understands why the deferral is needed before signing the "Client Acknowledgment" section.

11.3.5(c) The CSD 542 Weatherization Deferral form with assessor's and client's signatures shall be kept in the client file.

11.3.6 The presence of any of the following conditions that are not correctable within the weatherization program scope will require full or limited deferral of weatherization activities as defined below.

11.3.6(a) Full (required) deferral

11.3.6(a1) A home has fewer than three feasible measures (except ECIP EHCS measures).

11.3.6(a2) A client refuses CAS testing.

11.3.6(a3) A client has a health condition that would be made worse by weatherization activities.

11.3.6(a4) The home's mechanical, electrical, or plumbing system is in such disrepair that it is not correctable within the program.

11.3.6(a5) The home has sewage or sanitary problems, or pest infestation that endangers the client/crew if work is performed. Major repair is beyond the program scope.

11.3.6 (a6) Issues that make full assessment and/or diagnostic tests not feasible, such as: the home is condemned, under rehabilitation (being remodeled), has significant structural issues, or client hoarding limits accessibility.

11.3.6 (a7) Moisture issues are so severe that they cannot be fixed

11.3.6 (a8) The client is uncooperative, abusive, or threatening to weatherization personnel.

11.3.6 (a9) Extensive amounts of lead-based paint (or presumed lead-based paint) is deteriorated and requires remediation before weatherization work may be performed.

11.3.6 (a10) A portable propane tank is attached to an appliance in, or within 5' of, the living space

11.3.6 (a11) Dwelling conditions are present that could result in explosion.

11.3.6 (a12) Illegal activities are taking place in the home.

11.3.6 (a13) (DOE Program) A client refuses duct testing or shell leakage testing.

11.3.6 (a14) (DOE Program) A CAS or indoor air quality (IAQ) hazard exists that cannot be reasonably corrected within the scope of the program.

11.3.6 (a15) (DOE Program) When mechanical ventilation assessment requires a fan size of 16 CFM or greater, but the measure is:

- Structurally unfeasible in the home or
- The measure is refused by the client

11.3.6 (b) Limited deferral

11.3.6 (b1) Limited deferral is required when a circumstance is identified that will block the installation of other measures, as a single measure or as a group (type) of measures. The following are examples for LIHEAP only:

- One or more unvented space heaters are present that have a harmful effect on the air quality in the home. Until the unvented heater is removed, the home is restricted to non-infiltration measures (home is NIM).
- Mechanical ventilation (if applicable) is refused by the client or is structurally unfeasible (home is NIM).
- When a combustion appliance or hazardous air quality condition is present that cannot be corrected, the home is NIM. However, careful evaluation must be performed to determine if non-sealing measures are achievable, reasonable, and cost-effective and it is safe for workers to enter within program guidelines.
- Client refusal of a duct leakage or shell leakage diagnostic test renders the home NIM.

11.4. Asbestos Policy

11.4.1 Asbestos Regulation

11.4.1 (a) Asbestos fibers may cause damage to lungs if they are friable and inhaled. In accordance with the Cal/OSHA definition in the California Code of Regulations (CCR) Title 8, Section 5208, Appendix G:

11.4.1 (a1) “Friable” means that the material can be crumbled with hand pressure and is likely to emit tiny, sharp fibers. Asbestos material used for fireproofing, insulation, or sound proofing is considered to be highly friable and release airborne fibers if disturbed. Materials such as vinyl-asbestos floor tiles and roofing felt are considered typically non-friable unless subjected to sanding, sawing, or degradation. Asbestos-cement pipe or sheet (transite) can emit airborne fibers if the materials are cut or sawed, or if they are broken.

11.4.1 (b) The Environmental Protection Agency (EPA) has banned use of asbestos in most building materials.

11.4.1(c) The California Contractor's State License Board (CSLB) advises that asbestos should be presumed to be present in any structure built before 1980, unless there is proof the materials are asbestos-free (such as by laboratory testing).

11.4.1(c1) A material that is known to contain asbestos fibers is called an "asbestos-containing material (ACM).

11.4.1(c2) A material that has not been tested, but is presumed to contain ACM is known as a presumed-ACM or PACM.

11.4.2 Health and Safety Policies for Work with ACM/PACM

11.4.2(a) Work around ACM or PACM must be performed in accordance with guidelines set forth by the Contractors State License Board (CSLB), Cal/OSHA, and the Environmental Protection Agency (EPA).

11.4.2(a1) Agencies/subcontractors shall be knowledgeable regarding the laws pertaining to construction activities involving ACM.

11.4.2(a2) Training of field personnel about ACM and PACM policies will be the responsibility of agencies/subcontractors. No action may be taken that will disturb, expose, release, or discharge any ACM and in no case shall the agency authorize removal or disposal of ACM/PACM by individuals who are not certified to do such work.

11.4.2(a3) Where the presence of ACM/PACM or other potentially hazardous material is known or suspected, appropriate safety practices shall be followed to minimize exposure to airborne environmental hazards. Field personnel shall be required to use asbestos-safe work practices when ACM/PACM is present.

11.4.2(a4) Asbestos remediation costs will not be allowed; however, testing may be allowed by personnel who are properly trained to remove samples of material for laboratory testing (only when allowed by the state and local jurisdiction).

- Agencies and their subcontractors may not use abatement contractors to remove or dispose of asbestos-containing materials (ACM) without prior CSD authorization.

11.4.2(a5) Weatherization work around ACM/PACM shall be performed by personnel to conform with state and local regulations, which may include but are not limited to required trainings, use of PPE, wetting of suspected material, containment when needed, proper laundering of clothing, and other required practices.

11.4.2(a6) When an ACM is known to be present by testing (as completed by a certified contractor), the agency/subcontractor shall inform the property owner that an ACM is present, and describe the precautions that will be taken to eliminate exposure in writing. Additionally, agencies/subcontractors shall:

- Suspected asbestos hazards will be identified in furnaces (e.g., gaskets), wood stoves, zonal heating devices, electrical wiring insulation, boilers, and pipe insulation and corrected in accordance with EPA guidance
- Instruct occupant(s) to not disturb ACM/PACM locations, and recommend avoidance of those locations.
- When materials are tested, formally notify occupant(s) if test results are positive for ACM, and obtain a client signature confirming notification.
- Provide safety information to the client, from resources such as those listed at the end of this policy.
- Provide the client with contact information for these asbestos resources:
  - EPA Region 9 (California), 75 Hawthorne Street, San Francisco, CA 94105
  - Air Resources Board/Asbestos NESHAP Program, Phone: 833-280-0270

11.4.2(a7) A dwelling owner must contract with an EPA-certified asbestos contractor for abatement before weatherization is performed in an affected area (Owner is responsible for abatement or remediation work and costs). Once a clearance report is provided to the weatherization agency, work may resume.

11.4.2(b) When major energy saving measures might be sacrificed as a result of PACM, the agency/subcontractor shall contract with a qualified professional to obtain laboratory testing of PACM (e.g., for all vermiculite or un-encapsulated textured “popcorn” ceilings). This does not apply to metal air ducts/components insulated and/or sealed with gray paper-like material, which is PACM.

11.4.2(c) For work on large multi-family heating and distribution systems (including related piping), the cost of asbestos removal or a less costly approach such as encapsulation may be allowable with prior approval of CSD.

11.4.2(c1) This work will only be allowed where the documented energy savings will result in a SIR ≥1.0. In all cases, compliance with all local code and EPA regulations is required.

11.4.2(d) Encapsulation of non-friable asbestos in limited amounts may be allowed with prior approval by CSD on a case-by-case basis. Encapsulation is the process of covering (encapsulating) ACM in order to contain the fibers permanently. Possible locations include duct register boots containing intact asbestos tape, or rough edges of transite pipe. An approved encapsulation material may be applied however, such work shall be performed only by qualified personnel in accordance with state and federal regulations.

11.4.3 Crew Responsibilities with ACM/PACM

11.4.3(a) Asbestos-safe weatherization practices shall be utilized when working on building components which are known or suspected to be ACM in pre-1980 homes. Field personnel shall:

11.4.3(a1) Participate in all health and safety training for ACM and PACM safety practices.

11.4.3(a2) Clearly document the condition of all ACMs and PACMs (i.e., degraded and potentially friable versus intact and non-friable), material type, and precise location in the CSD 540 Dwelling Assessment form.

11.4.3(a3) Avoid disturbing, exposing, releasing, or discharging any ACM or PACM into the air.

11.4.3(a4) Use asbestos-safe work practices, including site preparation, use of PPE, and clean-up procedures when ACM/PACM are present using techniques and practices to prevent a hazard from being created in the living space. The use of properly-rated respirators and protective clothing is advised in situations involving low level, limited-time exposure. Wetting down PACM is also recommended.

11.4.3(a5) All dust and debris generated as a result of weatherization activities in areas where ACM is present shall be thoroughly cleaned up, using a HEPA vacuum, wetting, bagging, and all other state-mandated safety practices. (See CSLB publications references listed at the end of this section.)

11.4.4 ACM/PACM Classified by Type and Condition of Material

11.4.4(a) Homes built before 1980 are presumed to have asbestos-containing building materials, unless determined by laboratory certification. Table E-3 below lists some, but not all, common types and conditions of ACM/PACM.

11.4.4(b) The condition level (1, 2, or 3) determines procedures to be followed by field personnel, which are further described in Table E-4, Table E-5, and Table E-6.

11.4.4(c) Field personnel and their employers are responsible for recognizing ACM/PACM, and for conducting all weatherization activities affected by its presence in a manner prescribed by state law (See CSLB publications listed at the end of this document).

TABLE E-3: ACM OR PACM CONDITION LEVELS

ACM/PACM Component in a Pre-1980 Dwelling	Condition Level 1 Non-friable, intact, encapsulated (i.e., non-degraded, undamaged)	Condition Level 2 Non-encapsulated, potentially-friable, or partially damaged or degraded
• Supply system metal ductwork with ACM insulation on ducts, register boots, and other components, and/or ACM tape used to seal metal duct joints	• Intact, with no disconnections	• With evidence of damage, degradation, or duct disconnection(s)
• Return system metal ductwork with ACM insulation on ducts, register boots, and other components, and/or ACM tape used to seal metal duct joints	• Intact, with no disconnections	• N/A: See Condition Level 3
• "Transite" vent pipe (asbestos cement pipe)	• Intact	• Damaged or degraded
• Fireproof composite ACM, and asbestos insulation board (e.g., hearth and wall protectors for heating appliances, such as wood-burning stoves)	• Intact	• Damaged/degraded
• Textured ceiling (popcorn or coarse, bumpy texture)	• Intact, may be covered with paint	• N/A: See Condition Level 3
• Caulking compound	• Intact	• Damaged/degraded
• Drywall and drywall compound	• Intact	• Damaged/degraded
• ACM siding ("asbestos shingles")	• Intact	• Damaged/degraded
• Vermiculite ceiling insulation	• Lab-verified to not contain ACM	• Lab-verified to contain asbestos or presumed ACM.

ACM/PACM Component in a Pre-1980 Dwelling	Condition Level 3 Friable—damaged, degraded, crumbling, flaking—and is/may be discharging asbestos fibers into the air
• Rigid non-metallic ductwork made of ACM is present	• Regardless of condition, this is an unacceptable duct material
• Return system ductwork with partial/full disconnection(s) and/or unsound/friable ACM at leaking joints	• May allow asbestos fibers to enter the return system. Unacceptable.
• Textured ceiling (popcorn or coarse, bumpy texture) • Caulking compound • Drywall and drywall compound	• Characterized by crumbling or flaking. Unacceptable.
• Transite pipe	• Damaged, degraded, or requiring replacement to facilitate appliance replacement

If an ACM/PACM is encountered that is not on this list, consult with the Technical Assistance Hotline for guidance at (877) 831-7596 or Wx.Hotline@csd.cas.gov.

11.4.5 Diagnostic Testing and ACM

11.4.5(a) No pressure diagnostics and no duct or shell sealing of any kind is allowed—including catastrophic leakage repair—while an uncorrectable CAS fail or any hazardous (Level 3) ACM is present.

11.4.5(a1) Exception: When ACM is present but there is no CAS fail, weatherstripping and door bottom may be installed to isolate open combustion appliances from the living space (e.g., on a door between an attached garage and the home, or a door of an interior enclosure with CVA vents to outdoors).

TABLE E-4: DUCT AND SHELL TESTING/SEALING WITH ACM/PACM

Level	Condition/Approach	Duct Testing & Sealing	Shell Testing & Sealing
1	• ACM insulation/sealing on supply or return metal ducts is not degraded or friable and there are no disconnections.	• Duct testing is allowed, and duct sealing is allowed in locations where ACM will not be disturbed.	• Pressurized blower door test with registers and grilles blocked—and shell sealing—are allowed.
	• Transite pipe (intact in the living space, or with minor damage in the attic).	• Duct testing and sealing activities that will not disturb ACM are allowed.	• Pressurized blower door test with registers and grilles blocked—and shell sealing—are allowed.
	• ACM (in one or more of the following locations) is verified to be intact or encapsulated, and is in good condition and non-friable: − Fireproof composite ACM − Caulking compound − Asbestos insulation board − Drywall and drywall compound − Textured ceiling − ACM siding − Vermiculite confirmed to not contain asbestos	• Feasible	• Feasible
2	For each of the Level 2 materials listed below: ▪ Visually assess the level of friability of material in multiple locations and note on the assessment form ▪ Lab test if ACM is suspected but not confirmed [1] ▪ Visually check for metal duct disconnections [2]		
	• ACM insulation/sealing on metal supply ducts, and a disconnection exists or is presumed to exist (Note: ACM on return ducts with evidence of damage, degradation, or duct disconnection is a Level 3 condition)	• Duct test is not feasible, but prescriptive duct sealing that will not disturb ACM is feasible.	• Pressurized blower door test with registers and grilles blocked—and shell sealing—are allowed

TABLE E-4: DUCT AND SHELL TESTING/SEALING WITH ACM/PACM

Level	Condition/Approach	Duct Testing & Sealing	Shell Testing & Sealing
2	• ACM (in one or more of the following locations within the living space) is verified to be damaged or degraded: • Fireproof composite ACM • ACM drywall and drywall compound • Asbestos insulation board • ACM caulking compound • (Note: An un-tested textured ceiling with evidence of damage or degradation is a Level 3 condition)	• Duct testing and sealing activities that will not disturb ACM are allowed.	• Not feasible home is NIM, although special weatherstripping* shall be allowed • *Weatherstripping and door bottom may be installed to isolate open combustion appliances from the living space (on door between attached garage and the home, and door on interior enclosure with CVA vents to outdoors)
	• ACM siding is verified to be damaged or degraded	• Duct test is allowed, and duct sealing is allowed in locations where ACM will not be disturbed.	• Feasible
	• Vermiculite insulation verified to contain asbestos	• Duct testing and sealing activities that will not disturb ACM are allowed.	• Pressurized blower door test with registers and grilles blocked—and shell sealing—are allowed
3	• Any non-metallic ductwork made of ACM	• Not feasible home is NIM, defer home	• Not feasible home is NIM, defer home
	• Return system ductwork with partial/full disconnection(s) and/or friable ACM at leaking joints • Textured ceiling (popcorn or coarse, bumpy) • Caulking compound • Drywall and drywall compound • Transite pipe (damaged and crumbling, in the living space or enclosure vented to it)	• Not feasible, home is NIM	• Not feasible home is NIM, although special weatherstripping may be allowed • Weatherstripping and door bottom may be installed to isolate open combustion appliances from the living space (on door between attached garage and the home, and door on interior enclosure with CVA vents to outdoors)
	• Vermiculite insulation is verified to contain asbestos, and metal supply ducts with ACM are in the attic, but there is no duct disconnection	• Duct sealing that will not disturb ACM is allowed	• Pressurized blower door testing with registers and grilles blocked—and shell sealing—are allowed

TABLE E-4: DUCT AND SHELL TESTING/SEALING WITH ACM/PACM

Level	Condition/Approach	Duct Testing & Sealing	Shell Testing & Sealing
3	• Vermiculite insulation is verified to contain asbestos, and metal supply ducts with ACM are in the attic, and there is a duct disconnection	• Duct testing is not feasible, but prescriptive duct sealing that will not disturb ACM is feasible (e.g., platform return)	• Pressurized blower door testing with registers and grilles blocked—and shell sealing—are allowed

[1] Transite pipe and gray paper insulation and sealing tape on metal ducts/components are presumed to be ACM. Testing is not required.

[2] Disconnection presumed to exist, if all ductwork sealed or insulated with ACM cannot be accessed and visually checked.

TABLE E-5: CAS TESTING AND APPLIANCE REPAIR/REPLACEMENT

Level	Condition/Approach	CAS Testing/Appliance Repair or Replacement
1	• CAS fail exists, and intact transite vent pipe is present	• CAS testing is feasible • Appliance repair/replacement feasible, if ACM not disturbed
	• Other Condition Level 1 ACM situations exist	• Feasible, if ACM will not be disturbed
2	• CAS fail exists, and correction would require adjustment/repair/replacement of transite vent pipe, and the correction will cause ACM to be released or discharged	• Appliance replacement/repair is not feasible however, if the owner hires an asbestos remediation contractor to remove the ACM, then appliance repair/replacement by the CSD contractor is allowed
3	• Any non-metallic ductwork made of ACM	• CAS testing not feasible home is NIM and is deferred
	• Return system ductwork with partial/full disconnection(s) and/or friable ACM at leaking joints	• Do not operate the FAU the home is NIM and deferred • A partial deferral is an option, when required minimum number of non-infiltration measures can be installed
	• Textured ceiling (popcorn or coarse, bumpy) • Caulking compound • Drywall and drywall compound • Vermiculite insulation verified to be ACM	• CAS testing is feasible • Appliance repair/replacement that will disturb ACM is not feasible
	• Transite pipe (damaged or crumbling, in the living space or enclosure vented to it)	• CAS testing not feasible for the affected appliance • If affected appliance is the FAU, the home is NIM • If affected appliance is not the FAU, CAS testing, repair, replacement is feasible for other combustion appliances

11.5. Weatherization Installation Activities and ACM/PACM

11.5.1 The following weatherization measures (Table E-6 and Table E-7) may be affected by the presence of ACM:

TABLE E-6: MEASURE INSTALLATION AND ACM/PACM

Weatherization Measure	Location of ACM/ PACM	Recommended Action
• Ceiling Fans • Hardwired Fixtures	• Textured "Popcorn" Ceiling	• Contractors who are certified/trained to handle ACM may disturb limited quantity of material, as long as state requirements are met for containment, clean-up and reporting
• Smoke Alarms	• Textured "Popcorn" Ceiling	• Seek alternative installation location where ACM is not present
• Mechanical Ventilation	• Textured "Popcorn" Ceiling	• Seek alternative installation location where ACM is not present • Contractors who are certified/trained to handle ACM may disturb limited quantity of material, as long as state requirements are met for containment, clean-up and reporting • If contractor is not certified, measure is not feasible
• Wall Insulation	• Asbestos Shingles and Siding	• Do not cut, drill, or sand asbestos wall material • House siding containing asbestos shall not be drilled through or removed however, insulation may be blown from inside the home
• Ceiling Insulation	• (See Table E-7 Ceiling Insulation Installation and ACM/PACM below)	

TABLE E-7: CEILING INSULATION INSTALLATION AND ACM/PACM

Level	Condition/Approach	Ceiling Insulation
1	• Attic contains metal ducts/components, and ACM is not present on ducts	• Feasible
	• Attic contains vermiculite insulation verified to not contain asbestos (by prior certification or lab test)	• Feasible
	• Other Condition Level 1 ACM situations exist	• Feasible
2	• Attic contains metal ducts/components, and ACM is present on ducts	• Feasible only when there is no large leak or disconnection, and ACM will not be disturbed during installation (by the installer or insulation hose)
	• "Transite" vent pipe	• Feasible only when ACM will not be disturbed
	• Textured ceiling (popcorn or coarse, bumpy)	• Not feasible
	• Caulking compound	• Feasible
	• Drywall and drywall compound	• Feasible
	• ACM siding ("asbestos shingles")	• Feasible
3	• Attic contains rigid non-metallic ductwork made of ACM	• The home is NIM, and ceiling insulation is not feasible

TABLE E-7: CEILING INSULATION INSTALLATION AND ACM/PACM

Level	Condition/Approach	Ceiling Insulation
3	• Attic contains return system ductwork with partial/full disconnection(s) and/or friable ACM at leaking joints	• Not feasible
	• Attic contains vermiculite insulation verified to contain asbestos	• Not feasible. Insulation shall not be installed over vermiculite unless testing confirms asbestos is not present.
	• Attic contains transite pipe that is damaged and crumbling	• Not feasible
	• Textured ceiling (popcorn or coarse, bumpy)	• Ceiling insulation and sealing of thermal bypasses in the ceiling are not feasible
	• CAS testing is not feasible for an FAU, due to ACM “transite” vent pipe	• Home is NIM, but ceiling insulation may be installed if ACM will not be disturbed.
	• Duct and shell testing and sealing, and CAS testing, are not feasible	• Defer the home.

11.5.2 Additional Asbestos Resources

11.5.2(a) Air Resources Board of California (ARB): https://ww3.arb.ca.gov/toxics/asbestos/1health.pdf

11.5.2(b) California Department of Public Health (CDPH): https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHLB/IAQ/Pages/Asbestos.aspx

11.5.2(c) Environmental Protection Agency (EPA): https://www.epa.gov/asbestos, and https://www.epa.gov/indoor-air-quality-iaq/asbestos-impact-indoor-air-quality

11.5.2(d) Occupational Safety and Health Administration (OSHA): https://www.osha.gov/Publications/OSHA3507.pdf

11.5.2(e) Contractor’s State License Board (CSLB): “A Consumer Guide to Asbestos” available at https://www.cslb.ca.gov/Resources/GuidesAndPublications/AsbestosGuideForConsumers.pdf

11.5.2(f) For contractor-related asbestos information, go to: https://www.dir.ca.gov/dosh/ACRU/ACRUresources.htm

11.6. Lead Safe Weatherization (LSW) Policy

11.6.1 CSD weatherization program agencies and their subcontractors shall follow all applicable local, state, and federal laws and regulations pertaining to lead-based paint and lead hazards. They shall be aware of the potential hazards and conduct all activities in a “lead-safe” manner, avoid contaminating homes with lead-based paint dust and debris, and avoid exposing the clients, themselves, and their families to those hazards. It is therefore important that all agency personnel understand and follow this policy.

11.6.2 The requirements listed in this section and in Lead-Based Paint are not intended to be a complete list of practices for controlling and containing lead hazards; however, by using these suggested practices and common sense, lead poisoning from weatherization activities may be prevented.

11.6.3 LSW practices will apply if any of the following conditions are met:

11.6.3(a) The dwelling was built before 1978 and paint will be disturbed during the weatherization process, and

11.6.3(b) Weatherization agency assumes lead-based paint is present without testing.

11.6.4 LSW practices do not apply if:

11.6.4(a) The unit was built in 1978 or later

11.6.4(b) Paint will not be disturbed

11.6.4(c) A California-Certified Inspector/Risk Assessor conducted a lead paint inspection and found the unit to be “lead free”

11.6.4(d) A California-Certified Inspector/Risk Assessor conducted a limited lead paint inspection on surfaces which are to be disturbed by weatherization activities and found the surfaces to be “lead free”

11.6.4(e) The property is designated exclusively for occupancy by the elderly or disabled and only if no child (less than 6 years of age) resides or is expected to reside there (HUD, EPA)

11.6.4(f) The dwelling is a mobile home with all factory-applied paint (HUD and CDPH)

11.6.4(g) The dwelling is a zero-bedroom unit (EPA)

11.6.5 Required Dwelling Deferral

11.6.5(a) CSD policy is to not defer or abandon the weatherization of a home simply because it may contain lead-based paint. Risk can be reduced using lead-safe work practices; therefore, lead will only cause deferral when:

- 11.6.5(a1) The paint on a pre-1978 residential structure is in seriously deteriorated condition
- 11.6.5(a2) Large amount of paint chips are present on the ground or floor
- 11.6.5(a3) Painted surfaces that are to be worked on are in seriously deteriorated condition
- 11.6.5(a4) Reimbursement for a Clearance Inspection by a certified Inspection/Assessor for HUD units will not be provided by the property owner or local housing authority or CSD

11.6.5(b) If any of the above conditions exist, deferral of weatherization work would mean postponing the work until another agency or the owner has corrected the problem before weatherization can be safely performed (deferral of the home shall be on a whole-dwelling basis, and would not be allowed on a measure-by-measure basis). See Deferral and Referral Policy.

11.6.6 Lead-Related Regulations

11.6.6(a) Agencies/subcontractors are required to be knowledgeable about and follow all applicable regulations when weatherizing homes, including:

- 11.6.6(a1) California Department of Public Health (CDPH), CCR Title 17, Chapter 8 Accreditation, Certification and Work Practices for Lead-Based Paint and Lead Hazards
- 11.6.6(a2) Environmental Protection Agency (EPA) Renovation, Repair, and Painting (RRP) Rule
- 11.6.6(a3) Department of Housing and Urban Development Lead-Safe Housing Rule, 24 CFR Part 35 for work conducted on federal HUD properties
- 11.6.6(a4) California Department of Occupational Health and Safety (Cal/OSHA) Title 8, Section 1532.1 for employee exposure limits and testing
- 11.6.6(a5) Local lead-based paint regulations (check local codes). In California, some cities have instituted additional lead regulations that must be followed.

11.6.6(b) A summary of agency compliance triggers and activities for LSW is shown in Table E-8.

TABLE E-8: REGULATORY AGENCIES, COMPLIANCE TRIGGERS AND COMPLIANCE ACTIVITY

Regulatory Agency	Paint Disturbance Compliance Triggers (*de minimis* levels)	Compliance Activity
California Department of Public Health (CDPH)	• Pre-1978 • Any amount of paint • No test kit allowed*	• "Appropriate" containment and cleaning when any paint is disturbed.
U.S. Department of Housing and Urban Development (HUD) Lead-Safe Housing (LSH) Rule	• Pre-1978 • More than 2 sq. ft. per interior room • More than 20 sq. ft. of surface on the exterior • More than 10% of small building components (i.e., trim, baseboard, etc.	• "Appropriate" containment and cleaning when HUD *de minimis* levels are exceeded. • Prohibited activities shall not be used. • Clearance inspection and report by a CDPH-certified Inspector or Assessor is required.
U.S. Environmental Protection Agency (EPA) Renovation, Repair, and Painting (RRP) Rule	• Pre-1978 • More than 6 sq. ft. in any interior room • More than 20 sq. ft. on exterior surfaces	• Certified Renovator shall be on-site during all work. • Client Education Pamphlet shall be delivered and signature obtained. • "Appropriate" containment and cleaning when HUD *de minimis* levels are exceeded. • Prohibited Activities shall not be used. • Certified Renovator shall provide 1) a visual inspection and 2) cleaning verification at the end of the job • EPA-compliant documentation shall be kept in the client file.

*Lead testing clarification: CDPH does not allow the use of lead test kits to determine the presence or absence of lead, no matter how much area may be disturbed. Currently, CDPH only recognizes testing by a state-certified Inspector/Assessor using an XRF (x-ray fluorescence) tool or certified laboratory test to identify the presence of lead. Since EPA and CDPH both hold jurisdiction under the weatherization program, test kits in California are not allowed. CDPH presumes that lead is present for pre-1978 dwellings, and if they apply lead-safe practices when working on those homes, then no testing is required.

11.6.7 Lead Risk Factor Evaluation

11.6.7(a) The lead "risk factor" shall be evaluated for each measure in a pre-1978 dwelling before beginning weatherization work. The variation in risk depends on how much paint is disturbed and how it is disturbed. Certified Renovators shall evaluate the existing conditions and make the final determination of what containment and cleaning practices will be required.

11.6.7(a1) **No-Risk Measures.** Measure that will not require disturbance of any paint for its installation.

- Containment and cleaning procedures are not required.
- Required documentation: For CSD, EPA, and HUD compliance, CSD 708 Lead-Based Paint Regulatory Compliance Report, page 1 is required only.
- Warning: A "no-risk" measure may become a "high-risk" measure and require special actions if paint ends up being disturbed (example: a worker falls through a ceiling when installing insulation).

11.6.7(a2) **Low-Risk Measures.** Installation of these measures may generate minimal lead dust or debris. This classification applies when the amount of surface area to be disturbed is less than or equal to the EPA RRP or HUD de minimis levels (when applicable), and considered "minor repair or maintenance." Note: These activities do not trigger EPA RRP Rule requirements, but may trigger HUD's Lead-Safe Housing Rule if working on HUD-qualified housing.

- When conducting these activities, containment via lead-safe practices and thorough cleaning are required.
- While this type of work is not likely to disturb significant amounts of lead-based paint; it is the responsibility of the Certified Renovator to determine the extent of the lead-safe containment and cleaning practices that shall be performed appropriate to the amount of material disturbed.
- Required documentation: For CSD, EPA, and HUD compliance, the full CSD 708 Lead-Based Paint Regulatory Compliance Report shall be completed. Photographic documentation of job site set-up, containment, and clean-up activities may be required.

11.6.7(a3) **High-Risk Measures.** These measures will disturb more than the EPA's "de minimis" levels and generate significant quantities of paint dust and debris.

- They have the potential to create a "hazardous" condition for occupants and workers if lead-safe steps are not taken.
- These measures require high levels of containment, lead-safe work methods, and clean-up procedures.
- It is the responsibility of the Certified Renovator to determine the extent of the lead-safe containment and cleaning practices that shall be performed appropriate to the amount of material disturbed.

11.6.7(b) Required documentation shall be as follows (Table E-9):

Table E-9: Required Documentation by Regulatory Entity

Regulatory Entity	Required Documentation
CDPH	• Full CSD 708 Lead-Based Paint Regulatory Compliance Report shall be completed.
EPA	• Full CSD 708 Lead-Based Paint Regulatory Compliance Report shall be completed when de minimis is exceeded. • Photo documentation of job site set-up, containment, and clean-up is recommended. • Certified Renovator is required to perform: 1) jobsite monitoring, and 2) visual inspection and cleaning verification of all affected work areas. Certification of results shall be recorded in the CSD 708 Lead-Based Paint Regulatory Compliance Report.
HUD	• Full CSD 708 Lead-Based Paint Regulatory Compliance Report shall be completed when de minimis is exceeded. • Photo documentation of job site set-up, containment, and clean-up is recommended. • A Clearance Inspection from a CDPH-certified inspector/assessor is required. • (Note: Clearance inspection of only the worksite area is permitted only when containment was used to ensure that dust and debris generated by the work is kept within the worksite. Otherwise, the clearance inspection shall be of the entire dwelling unit, common area, or outbuilding, as applicable.)

11.6.8 Worker Exposure Limits

11.6.8(a) The Cal/OSHA workplace lead regulations (CCR Title 8, Section 1532.1) apply when:

11.6.8(a1) Conducting new construction, alteration, repair, or renovation of structures, substrates, or portions thereof that contain lead or materials containing lead

11.6.8(a2) Any painted surfaces are disturbed and workers may be exposed to a lead.

11.6.8(a3) Exposure exceeds the action level (AL) of 30 micrograms/cubic meter ($\mu g/m^3$) per 8-hour total weight average (TWA). The action level triggers several ancillary provisions of the standard such as exposure monitoring, medical surveillance, and training.

11.6.8(a4) Exposure exceeds the permissible exposure limit (PEL) of 50 micrograms/cubic meter ($\mu g/m^3$) per 8-hour TWA. Additional requirements shall be observed when the PEL is exceeded.

11.6.8(b) In accordance with Cal/OSHA regulations, all contractors who conduct construction work where an employee may be exposed to lead are required to:

11.6.8(b1) Conduct an initial exposure assessment to determine if employees are exposed to airborne concentrations of lead at or above the AL; and

11.6.8(b2) Monitor the workplace while construction activities that may disturb lead are conducted, unless it can be proven that employees are not exposed to lead at or above the AL; or

11.6.8(b3) Treat employees as if they are working above the PEL if activities include manual demolition of structures, manual scraping, manual sanding, heat gun applications and power tool cleaning with dust collection systems; and

11.6.8(b4) Have a written compliance program in place before starting a project where lead is or may be involved.

11.6.8(c) The Cal/OSHA regulations require that employers provide or include, if working at or above the PEL, the following:

11.6.8(c1) Engineering and work practice controls

11.6.8(c2) Signs

11.6.8(c3) Respiratory protection

11.6.8(c4) Protective work clothing and equipment

11.6.8(c5) Housekeeping, which includes cleaning of work areas as needed and the use of HEPA vacuums to remove lead dust

11.6.8(c6) Hygiene practices, including showers

11.6.8(c7) Lead abatement certification training

11.6.8(c8) Biological monitoring (blood lead testing)

11.6.8(d) When exposures are below the PEL (for most if not all weatherization work) agencies/ subcontractors should provide:

11.6.8(d1) Housekeeping (HEPA vacuum, wet clean-up, or other effective methods).

11.6.8(d2) Hand-wash facilities.

11.6.8(d3) Training as specified in §1532.1.

11.6.8(d4) Appropriate respirator protection and personal protection equipment.

11.6.8(e) For certain highly hazardous tasks, also known as trigger tasks, special protective measures shall be taken, including specified respirators, until the employer determines the workers' airborne exposure to lead are below PEL.

11.6.9 Lead-Safe PPE

11.6.9(a) Field personnel are required to wear adequate protection while working with presumed lead material to prevent the spread of lead dust and debris, which will keep workers safe, reduce the potential for dust to exit the work area, and to keep work area clean (Fig. E-1).

11.6.9(b) Depending on the amount of paint to be disturbed and risk factor of work to be performed, the recommended PPE is:

FIG. E-1: PERSONAL PROTECTIVE EQUIPMENT

11.6.9(b1) No-risk activities: No PPE is required.

11.6.9(b2) Low-risk activities: Workers may choose to wear PPE, however:

- All clothes or PPE shall be cleaned in accordance with the procedures listed in these requirements:
  - Work clothes shall not be worn home by workers but shall be:
    - "Contained" before leaving the worksite in accordance with CDPH and Cal/OSHA policies or
    - Properly cleaned and laundered (when not disposable) to remove all traces of presumed leaded dust

11.6.9(b3) High-risk activities: Workers must wear PPE while conducting these activities.

- Tyvek or work clothes shall not be worn home by workers but shall be:
  - "Contained" in accordance with CDPH and Cal/OSHA policies before leaving the worksite and
  - Properly laundered/cleaned to remove all traces of presumed leaded dust
- Lead-safe PPE shall include:
  - Half-face, National Institute for Occupational Safety and Health (NIOSH)-approved, air purifying respirators with N-100, R-100, or P-100 type particulate filters
  - Disposable work clothing that may include a painter's hat or Tyvek hood Tyvek or polyspun suit or coveralls, and shoe covers or booties
  - Removal of work clothing, including booties before stepping off the poly to leave the work area. This prevents the movement of leaded dust throughout the building, in the work vehicle, and transfer to the shop or home
  - Alternatively, Cal/OSHA allows the use Tyvek suits or washable work clothes (i.e., uniform, coveralls), provided that the clothing is HEPA-vacuumed, removed, and stored properly before leaving the worksite. Bagged clothing must be collected at the end of each job and washed at least once a week in accordance with CDPH and Cal/OSHA policies (the agency's responsibility)
  - Optional PPE also includes gloves (cloth, plastic, or rubber as appropriate) and eye protection

11.7. LSW Minimum Work Standards for Field Personnel

11.7.1 The remainder of this section is a guide for lead-safe weatherization practices that will reduce or eliminate lead hazards addressed herein. It supports work practices required by DOE, Cal/OSHA, CDPH, the EPA RRP Rule, and HUD's LSH Rule.

11.7.2 Agency/Subcontractor Responsibilities

11.7.2(a) Federal law requires that all firms performing renovations must ensure that:

11.7.2(a1) All individuals performing activities that disturb painted surfaces on behalf of the firm are either certified renovators or have been trained by a certified renovator

11.7.2(a2) A certified renovator is assigned to each renovation and performs all of the certified renovator responsibilities

11.7.2(a3) All renovations performed by the firm are performed in accordance with the work practice standards of the Lead-Based Paint Renovation, Repair, and Painting Program (RRP)

11.7.2(a4) Pre-renovation education and lead pamphlet distribution requirements of the Lead-Based Paint Renovation, Repair, and Painting Program are performed

11.7.2(a5) The program's record keeping requirements are met

11.7.3 Certified Renovator Responsibilities

11.7.3(a) The Certified Renovators are responsible for ensuring overall compliance with the Lead-Based Paint Renovation, Repair and Painting Program's requirements for lead-safe work practices. An EPA Certified Renovator shall:

11.7.3(a1) Determine if compliance with the RRP Rule is required

11.7.3(a2) Use an EPA-recognized test kit to determine whether components affected by the renovation contain lead-based paint, or assume lead-based paint is present for housing and buildings covered by this rule, unless testing is done that determines the components affected are lead-free

11.7.3(a3) Determine the type and extent of lead-safe work practices at each job site and provide on-the-job training to other workers (who have not taken the Certified Renovator training course) on the lead-safe work practices to be used in performing their assigned tasks

11.7.3(a4) Be physically present at the worksite when warning signs are posted, while the work area containment is being established and while work area cleaning is performed

11.7.3(a5) Regularly direct work being performed by other individuals to ensure that the work practices are being followed, including maintaining the integrity of the containment barriers and ensuring that dust or debris does not spread beyond the work area

11.7.3(a6) Be available, either on-site or by telephone, at all times during renovation

11.7.3(a7) Perform worksite cleaning verification

11.7.3(a8) Have copies of their initial course completion certificate and their most recent refresher course completion certificate at the worksite

11.7.3(a9) Prepare required records. (For a sample checklist of required records, see www.epa.gov/lead/pubs/samplechecklist.pdf)

11.7.4 Required Worker Safety Procedures

11.7.4(a) Workers using PPE during hot weather may experience heat stress. Workers should be provided with training on heat stress and exhaustion, be provided adequate breaks, have constant availability of water away from the worksite, and access to other re-hydrating liquids.

11.7.4(b) Limit occupant access to the work area. Occupants, children, and pets shall be kept out of the work area at all times until after visual inspection and cleaning verifications prove that the surfaces are clean and free from lead-containing dust.

11.7.4(c) Clients shall be informed what lead-safe work will be done and how long it will take before any work begins, so they may plan to be clear of the area.

11.7.4(d) During weatherization work, workers shall wash your hands and face frequently, particularly when leaving the work area and especially before leaving the area for the purpose of eating, drinking, or smoking. Absolutely no smoking, drinking, or eating is allowed in the work area.

11.7.4(e) All interior and exterior site preparation practices, containment work, and clean-up activities shall be followed as defined by the Certified Renovator.

11.7.4(f) In accordance with Cal/OSHA regulations, workers are required to wear monitors and have annual medical exams to check blood lead levels. Lead related work should not be performed by a worker if blood-lead levels are too high.

11.7.4(g) Workers must inform their employer if signs of lead poisoning are identified.

11.7.5 Prohibited Lead-Safe Field Practices

11.7.5(a) When working in pre-1978 homes, it is prohibited to:

11.7.5(a1) Reuse poly material used as protective containment sheeting. Polyethylene is the only acceptable protective containment sheeting and shall never be reused.

11.7.5(a2) Dry sweep using brooms and never use shop vacuums for any lead-safe work and cleanup. Wet cleaning and HEPA vacuums are the only acceptable methods for lead-safe weatherization work and clean-up.

11.7.5(a3) Cut a painted door inside a home.

11.7.5(a4) Use a conventional shop vacuum with HEPA filters. Only HEPA-designed vacuums are acceptable for LSW.

11.7.5(a5) Turn leaded paint into leaded dust by dry scraping or sanding (unless within 1' of electrical outlets/switches) or grinding, abrasive blasting or planing.

11.7.5(a6) Use machine/power sanders, grinders, abrasive blasting, or sandblasting without HEPA vacuum attachments (shroud)—even on a small surface—create a large amount of leaded dust that floats in the air and then settles on surfaces inside and outside the work area.

11.7.5(a7) Use an open-flame torch or heat gun (above 1100°F) to remove paint or window glazing.

11.7.5(a8) Use open flame/high heat methods to remove paint create fumes that are dangerous for workers to breathe. Small lead particles created by burning and heating also settle on surrounding surfaces and are very hard to clean up.

11.7.5(a9) Smoke, drink, or eat in the lead-safe work area or allow dwelling occupants to do so.

11.7.6 LSW Client Education and Notification

11.7.6(a) Clients with pre-1978 homes to be weatherized receive EPA's "Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools" prior to the start of any work on the unit. A copy of the client-signed CSD 321 Client Education Confirmation of Receipt is required to be kept in the client file.

11.7.6(b) An adult tenant or homeowner must sign acknowledgment that the lead-safe activities will be completed after receiving the pamphlet. The pamphlet can also be sent by certified mail with receipt to be placed in the client file.

11.7.6(c) In multi-unit housing, the agency/subcontractor shall:

11.7.6(c1) Provide written notice to each affected unit (notice shall describe: general nature and locations of the planned renovation activities; the expected starting and ending dates; statement of how occupant can get pamphlet at no charge); or

11.7.6(c2) Post informational signs (signs shall describe general nature and locations of the renovation and the anticipated completion date) and post the EPA pamphlet. (If pamphlet is not posted then agencies are required to provide information on how interested occupants can review a copy of the pamphlet or obtain a copy at no cost from the Weatherization Program).

- Warning signs also shall be posted at entrances to the worksite when occupants are present; at the main and secondary entrances to the building; and at exterior work sites. The signs shall be readable from 20 ft. from the edge of the worksite. Signs should be in the occupants' primary language, when practical.

11.7.6(c3) Delivery to owner/occupant. Owner's and/or occupant's signature with acknowledgment or certificate of mailing. The owner/occupant must acknowledge receipt of the EPA pamphlet prior to start of renovation that contains the address of unit undergoing renovation, name and signature of owner or occupant, and the date of signature. It shall be in same language as "contract for renovation" for an owner-occupied (or the same language as the lease for occupant of non-owner occupied) target housing.

If the Weatherization Program cannot obtain a signed acknowledgment (either the occupant is not home or refuses to sign the form), then the self-certification section of the form shall be signed to prove delivery.

The acknowledgment form shall be filed and remain in the client file for three years from date of signature. In addition to providing a copy of the pamphlet to owners and occupants, designated local agency staff (e.g., intake specialist, auditor, crew chief) shall discuss the hazards associated with lead-based paint and lead dust, and describe how they will conduct lead-safe activities in the home.

11.7.7 Containment

Every pre-1978 job where paint will be disturbed requires Containment, Cleaning, and Certification. The level of this work will vary depending on if a low-risk or high-risk measure is being installed.

11.7.7(a) Containment is the active control of lead dust and debris in the work site. It is required by the State of California whenever lead-based paint or presumed lead-based paint is disturbed. It includes measures taken to ensure that dust and debris created or released during weatherization are not spread, blown, or tracked from inside to outside of the worksite perimeter.

11.7.7(b) The set-up of the worksite shall be performed appropriate to the amount of painted surface to be disturbed, with the specific containment methods to be defined by a Certified Renovator. The following containment practices shall be used when applicable.

11.7.7(b1) Worksite preparation

- The Certified Renovator shall direct the containment of the work area so that dust or debris does not leave the area while the work is being performed.
- For interior work areas, signs shall be posted outside room where work will be performed (interior 5' set-back of at least is recommended) to warn occupants.
- Exterior work areas shall post signs and limit access at least 20' from the work zone (Fig. E-2).
- Ensure containment does not interfere with occupant and worker egress in an emergency.

Fig. E-2: Renovation Caution Sign

11.7.7(b2) Interior containment

- Low-risk, minimal: 6-mil polyethylene sheeting (also called “poly”) shall be spread immediately below the work area.
- Low-risk, moderate: Poly should extend up to 6' on all sides from the work area, and an additional second layer of sheeting shall be added over the work area to facilitate clean-up of dust. Poly sheets shall be tightly secured above the baseboard using 2" painters’ tape. Duct tape perimeter of the poly sheet to the carpet (Fig. E-3).
- Note: Polyethylene sheets can be very slippery, thus extreme caution should be observed when walking on sheets.

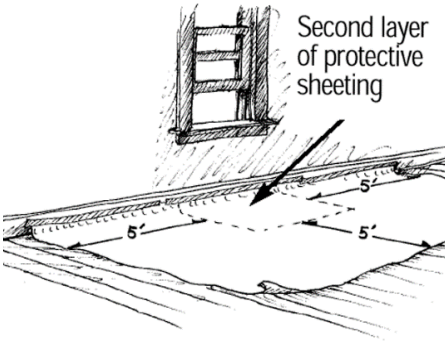


Fig. E-3: Level 2 Containment: Poly Sheeting 6' Beyond Work Area

- For some Low-risk containment, it may be necessary to:
  - Close and seal all windows/doors in the work area.
  - Shut off or seal air flow—i.e., HVAC equipment or vents, or ceiling fans when present.

- High-risk containment is required when the EPA or HUD de minimis levels will be exceeded.
  - Requires an expanded containment area (6' beyond the immediate work for interiors).
    - Where possible, remove belongings and furniture from the expanded work area, including: furniture, rugs and window coverings.
    - Completely cover all immovable fixtures, furniture, carpets and other personal items with protective sheeting.
    - Seal the seams and edges with tape (Fig. E-4).
    - Secure protective sheeting to the floor with tape so that no dust can get onto the covered items.

Fig. E-4: Sealing a Barrier Wall

  - High-risk containment also requires:
    - Covering of all horizontal surfaces
    - Constructing barrier walls (Fig. E-5)
    - Closing and sealing doorways and windows in the work area
    - Covering HVAC registers, turning off HVAC equipment
    - Shutting off and covering ceiling fans, etc.

Fig. E-5: Vertical Containment with a Barrier Wall

11.7.7 (b3) Exterior containment

- Low-risk, minimal: 6-mil poly shall be spread below the work area.
- Minimize creation of dust by using:
  - Hand tools (instead of power tools)
  - Working wet
  - HEPA-shrouded power tools
  - Catch bags
- High-risk:
  - Cover nearby plants, vegetable gardens, and children's play areas with poly sheeting (Fig. E-6).
  - Move all play equipment/toys at least 10' away from the work area and cover in place.
  - Cover the wall 10' to either side of the work location and spread poly at least 10' out from the base of the wall.

Fig. E-6: Exterior Containment

  - Secure the poly to the wall using 2" blue painter's tape, or anchor it so that there are no gaps between the plastic and the wall.
  - Anchor the edges of the poly with heavy objects.
  - Anchor ladders through a slit in the plastic directly to the ground, then tape around the slit.

- Some high-risk jobs may require extra precautions:
  - If possible, extend the area of ground covered by poly.
  - If conditions are windy, if space is limited, or if adjacent properties are close to the work area, vertical containment is required (Fig. E-7).
  - On days with high winds, it is not advisable to perform dust creating activities. The HUD LSH Rule restricts exterior work in winds in excess of 20 miles per hour. The EPA RRP Rule does not address wind speed; however, extra precautions shall be taken.

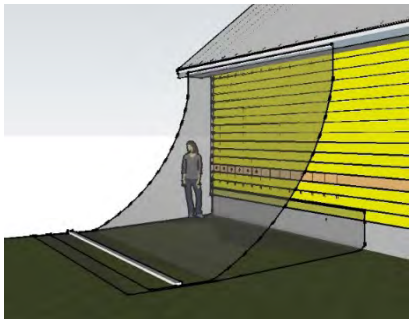


FIG. E-7: VERTICAL CONTAINMENT ATTACHED TO BUILDING EAVE

11.7.7(b4) Supplemental containment practices

- Create an Outdoor Lead-Safe Work Area
  - Set up a “lead-safe” work area, outside away from the residence, with adequate poly sheeting and containment methods to prevent the spread of dust and debris, and in a wind protected area.
  - Place 6-mil poly on ground or floor so that it is at least 6 feet out around the cutting area.
  - Locate any work sawhorses in the center of the plastic sheet.
- Catch bags
  - Make a “catch bag” by taping a 6-mil poly bag directly under the work to catch debris (Fig. E-8).
  - Install a stiffening frame with wire inside the bag to keep it open, when needed.
  - Use painter’s tape to secure the catch bag to painted surfaces. Do not use duct tape; as it may remove the paint.
  - If the debris (pieces of broken glass) is likely to break or cut the bag open, place the catch bag in a box or bucket.

FIG. E-8: USING A CATCH BAG AND WET MISTING

- Wet misting/working wet
  - Working wet is the most important LSW practice for minimizing the creation and spread of leaded dust.
  - Mist a work area before and while drilling, sawing, or prying (Fig. E-9).
  - Use battery-powered tools or hand tools when wet misting.
  - Use a GFCI to prevent shocks if power tools are used.
  - Do not spray water on the electric motor.

FIG. E-9: WORKING WET

- HEPA vacuum and tools with HEPA-attached shroud
  - Have one person hold the nozzle of a HEPA vacuum under the drill bit to catch the dust and debris as it is being produced (Fig. E-10).
  - Shrouded tools connected to HEPA vacuums also help contain dust and debris.

- Cutting or taping paint edge
  - Scoring paint before separating components prevents paint from chipping when a paint seal is broken.
  - Cut the paint bead between the trim and wall, and the trim and jamb, with a utility knife (Fig. E-11).
  - If not possible to cut the paint, carefully tape the edge to help control any dust created.
  - Gently pry off and remove object carefully (i.e., trim, door jamb, etc.). Prying and pulling apart components is a cleaner work practice. Pulling nails instead of pounding creates less dust and fewer paint chips.
  - If any dust is being generated, lightly mist it with water.

FIG. E-10: HEPA SHROUDED POWER TOOL

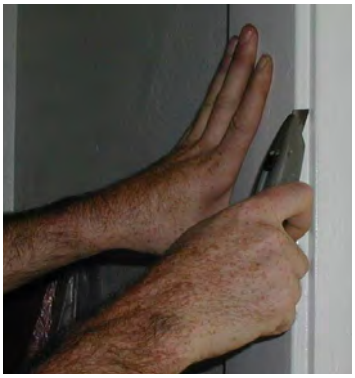


FIG. E-11: CUTTING THE PAINT BEAD ON TRIM

11.7.8 Jobsite Cleaning

11.7.8(a) Precautions shall be taken to ensure that all work personnel, tools, and surfaces are free of dust and debris during weatherization work and before workers have left the work area. Jobsite cleaning requires periodic (intermittent) and final clean-up activities.

11.7.8(b) Following the renovation, the work area must be cleaned until no dust, debris or residue remains and all waste that has been collected from renovation activities shall be collected and disposed of properly. Final cleaning of the work area is required to include:

11.7.8(b1) Complete HEPA vacuuming of the work area, workers, tools, etc.; and,

11.7.8(b2) Wet washing with a detergent cleaner. Wet washing consists of spraying a cleaner on the area to be cleaned and washing the area with a clean rag or disposable towel until all surfaces in the work area are clean and dried.

11.7.8(c) Required intermittent cleaning (while a job is in progress)

11.7.8(c1) While working on a weatherization task, place debris directly in the 6-mil collection bags.

11.7.8(c2) Keep work areas clean by removing debris and HEPA vacuuming floor/ground cover immediately after completing each work activity.

11.7.8(c3) Periodically use the HEPA vacuum to clean off workers, tools, and the work area if sufficient dust is created that may be spread (Fig. E-12).

11.7.8(c4) If any worker will leave the work area while the job is in progress, PPE must be cleaned, removed, and bagged appropriately. Before re-entering the work area, new PPE must be put on.

FIG. E-12: HEPA VACUUM ALL SURFACES

11.7.8(c5) Before re-installing doors, thresholds, or windows, HEPA vacuum the rough opening to remove all dust and debris.

11.7.8(c6) Use the HEPA vacuum to clean dust from all work surfaces and the surrounding area, then wet mist and wipe each surface clean prior to reinstalling (Fig. E-13).

11.7.8(d) Required 9-step final cleaning

11.7.8(d1) Step 1: Pick up visible debris

- Pick-up all visible paint chips and debris and discard or wrap component parts in plastic sheeting.

- The main point of cleaning is not to let dust spread beyond the work area. For exterior jobs, focus specifically on the areas that children could have access to such as bare soil, play areas, exterior porches and exterior window sills. Always inspect beyond the work area.
- Secure containers or catch bags with duct tape.
- HEPA vacuum and wet-clean the containers used to pick up debris.

Fig. E-13: Wet Mist and Wipe All Surfaces

11.7.8 (d2) Step 2: Clean all tools in the work area

- While working on the floor containment poly sheeting, HEPA vacuum and damp wipe (using a detergent-soaked cloth) all tools, equipment and cords, including the HEPA vacuum and hose. Dispose all wipes in a 6 mil plastic bag.
- Once cleaned, all tools, except the HEPA vacuum can be stowed in sealed hard-sided tool container(s).
- Wet wipe and remove containers from the containment area.

11.7.8 (d3) Step 3: HEPA vacuum surfaces from high to low

- HEPA vacuum the entire contained work area surfaces from high to low. Start with the walls (house walls as well as any poly walls), tops of doors, and window troughs (high) and work your way down to the floor (Fig. E-14).
- HEPA vacuum all surfaces worked on or that are near the work area.
- Vacuum the protective floor sheeting last.

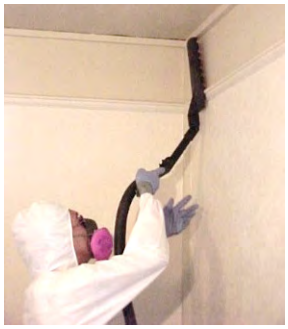


Fig. E-14: HEPA Vacuum From High to Low

11.7.8 (d4) Step 4: Wet clean surfaces from high to low

- Wet clean the surfaces using a household detergent or wet wipes.
- When cleaning wet, you can either mist the surface with cleaning solution or use a wet disposable cloth (Fig. E-15).
- Work from high surfaces to low.
- If a surface is very dirty use a moist paper towel before using the wet cloth.
- Replace cloths and change rinse water often.

Fig. E-15: Wet Surfaces From High to Low

11.7.8 (d5) Step 5: Cleaning of PPE/workers

- While standing on the ground containment poly sheeting, HEPA vacuum and damp wipe personal protective clothing (Fig. E-16).

Fig. E-16: Cleaning PPE

11.7.8(d6) Step 6: Remove all poly sheeting

- Indoors
  - Starting with wall and furniture poly indoors (or exterior vertical) poly containment, carefully remove the plastic and lay it on the floor poly sheeting (Fig. E-17). While standing on the floor containment, tightly fold the plastic together (do not shake or rattle plastic), with the lead exposed side folded to the inside. Once folded, tightly roll the plastic and place it in a large 6-mil plastic bag or two heavy duty bags.

Fig. E-17: Removing Interior Poly

  - HEPA-vacuum the floor/ground poly and all worker PPE thoroughly.
- Outdoors
  - Remove poly floor/ground cover(s) by carefully pulling the tape and folding the corners of the poly sheet to the middle of the sheet tightly, and continue folding with the lead-exposed side always on the inside of the fold (Fig. E-18).

Fig. E-18: Removing Poly Ground Cover

Fig. E-19: Poly Disposal

  - Tape the poly sheeting up and place the folded sheet in a 6-mil debris collection bag (Fig. E-19). Secure bags in accordance with EPA RRP requirements.
- Properly dispose of the poly film in accordance with requirements of CDPH and the local jurisdiction.
- Never re-use poly sheeting

11.7.8(d7) Step 7: Clean floor surface (interiors only)

- Remove booties before stepping off the poly sheeting. If booties are not worn, shoes shall be carefully cleaned using a HEPA vacuum cleaner before stepping off the poly sheeting.
- HEPA vacuum area under the poly and up to 2' beyond.
- If the floor surface under the poly is washable (carpet is not), spray/mist the detergent solution on the surface and wipe it clean (Fig. E-20).
- For carpeted floors HEPA vacuum the area that was under the poly sheeting and at least 2 feet beyond it. The HEPA vacuum shall have a beater bar for vacuuming carpet.

Fig. E-20: Spray/Mist Washable Floors

11.7.8(d8) Step 8: Final personal cleaning (Fig. E-21)

- Never leave a work site wearing dirty/dusty work clothes or disposable clothing.

- HEPA vacuum work clothes before removing them. From outside the house, gently remove your personal protective clothing and dispose with other debris.
- Use disposable cleaning cloths to clean yourself and respirator before entering your work vehicle or re-entry into the home.
- Dispose the wipes with other debris.
- Secure your respirator in its protective container.
- Before allowing occupants to re-enter the work area, visually inspect the area for dust—if necessary repeat HEPA vacuum and wet cleaning. If a clearance inspection or a Certified Renovator inspection is required, do not allow occupants into the work area until the inspection is complete and the work "passes" inspection.

FIG. E-21: FINAL PERSONAL CLEANING

11.7.8 (d9) Step 9: Disposal of debris

- Collect all disposable PPE and other personal cleaning debris in 6-mil plastic bags.
- Tie bags in accordance with EPA RRP requirements.
- Properly dispose of all debris in accordance with requirements of the local jurisdiction. Do not place in garbage collection bins at the dwelling.
- Dispose of all collected debris in 6-mil plastic bags at a location that is in accordance with CDPH requirements and local code.

11.7.9 Certification Requirements

11.7.9 (a) Under the EPA RRP Rule a visual inspection and cleaning verification of each work area shall be performed by the Certified Renovator after the cleaning is completed. If the housing also receives HUD (federal) assistance, a clearance inspection conducted by a Certified Lead Inspector/Assessor or Certified Lead Sampling Technician is also required.

11.7.9 (b) Within 48 hours of the completion of all cleaning, the Certified Renovator shall visually inspect the indoor and/or outdoor work area to confirm that the entire area is free of dust, paint debris, or residue. For exterior projects, when work areas have passed the visual inspection, the project is complete and the area may be turned over to the occupants. When interior project work areas have passed the visual inspection, the Certified Renovator shall perform the cleaning verification procedure.

11.7.9 (c) The cleaning verification shall be performed by wiping each horizontal surface and non-carpeted floor with a new, wet cloth. When compared against an EPA cleaning verification card, if the cloth does not "pass" then the cleaning shall be re-performed.

11.7.9 (c1) The cleaning verification test is then performed again with another wet cloth. If the second cleaning does not pass the renovator shall re-clean, wait one hour and wipe the surface with a dry electrostatic charged cloth.

11.7.9 (d) If the weatherization activity does not meet the triggers for the EPA Rule or the HUD Lead-Safe Housing Rule, the Crew Supervisor shall conduct an on-site visual inspection of each work area to ensure that it has been cleaned properly.

11.7.9 (d1) All final inspection and verification shall be completed, confirmed, then certified by the Renovator responsible for the project on the CSD 708 Lead-Based Paint Regulatory Compliance Report final page.

11.7.9(e) Certification/inspection documentation

11.7.9(e1) CSD required final inspection—The Certified Renovator shall complete the CSD 708 Lead-Based Paint Regulatory Compliance Report, final page.

11.7.9(e2) EPA final inspection—Inspection by a Certified Renovator is required when the project disturbs more than the EPA de minimis level. Inspection consists of two parts:

- Visual inspection (Looking for paint dust and other leftover debris)
- Post-renovation cleaning verification

11.7.9(e3) HUD clearance inspection—A Clearance Inspection is required from a Certified Lead Inspector/Assessor when the work on a HUD home disturbs more than the HUD de minimis level (this person is not the same as a Certified Renovator, and a different report format is used).

11.7.10 Lead-Safe Resources

11.7.10(a) California Department of Public Health

11.7.10(a1) CDPH Childhood Lead Poisoning Prevention Branch: http://www.cdph.ca.gov/programs/clppb/Pages/default.aspx

11.7.10(b) Cal/OSHA

11.7.10(b1) Cal/OSHA Lead in Construction Standard, Title 8 CCR Section 1532.1 https://www.dir.ca.gov/Title8/1532_1.html

11.7.10(c) U.S. Department of Housing and Urban Development

11.7.10(c1) HUD Regulation—Lead-Safe Housing Rule-Title 24 CFR35 (Part 35) https://www.hud.gov/program_offices/healthy_homes/enforcement/lshr

11.7.10(c2) U.S. Environmental Protection Agency

11.7.10(c3) EPA Regulation Residential Lead-Based Paint Hazard Act of 1992 “Pre-Renovation Education Rule, Section 406 https://www.epa.gov/lead/lead-renovation-repair-and-painting-program-rules

11.7.10(c4) EPA RRP Rule https://www.epa.gov/lead/lead-renovation-repair-and-painting-program

11.8. Radon Policy

11.8.1 By CSD policy, all clients, irrespective of county location, shall receive and acknowledge receipt (CSD 321 Client Education Confirmation of Receipt) of the EPA pamphlet “A Citizen’s Guide to Radon” (current edition from: https://www.epa.gov/radon/citizens-guide-radon-guide-protecting-yourself-and-your-family-radon.

11.8.2 Furthermore, in accordance with regulation by the California Department of Public Health, in no circumstance is radon testing or remediation allowed within the CSD weatherization programs’ work scope.

12. AGENCY AND SUBCONTRACTOR RESPONSIBILITIES

12.1 Each network agency and their subcontractor(s), not CSD, is responsible for the health and safety of its workers. All agencies shall develop their own individualized health and safety plans, which shall contain—at a minimum—all components included in this CSD Health and Safety Requirements appendix, and the Cal/OSHA components identified below. Each agency is required to provide current copies of its safety plans to be kept on file with CSD.

12.2. Cal/OSHA Required Documents

12.2.1 Each network agency and applicable subcontractor must have the following Cal/OSHA-required documents on file and be able to provide them to CSD upon request:

12.2.1(a) An injury and illness prevention program (IIPP)

12.2.1(b) A hazard communication (HazCom) program

12.2.1(c) A respirator protection program (RPP)

12.3. IIPP Requirements

12.3.1 The IIPP must be a written plan that conforms with Title 8, Section 3203 of the General Industry Safety Orders, Title 8, Section 1509 for those in the construction field, and Section 6401.7 of the California Labor Code. For IIPP development guidelines, see the Cal/OSHA eTool at http://www.dir.ca.gov/dosh/etools/09-031/

12.3.2 The Plan describes, at a minimum, the following elements:

12.3.2(a) Management commitment/assignment of responsibilities

12.3.2(b) Safety communications system with employees

12.3.2(c) System for assuring employee compliance with safe work practices

12.3.2(d) Scheduled inspections/evaluation system

12.3.2(e) Accident documentation and investigation

12.3.2(f) Procedures for correcting unsafe/unhealthy conditions

12.3.2(g) Safety and health training and instruction

12.3.2(h) Recordkeeping and documentation

12.3.3 For the IIPP, agencies and their subcontractors are required to:

12.3.3(a) Establish, implement, and maintain an effective IIPP

12.3.3(b) Adopt a written Code of Safe Practices, which defines the employer's operations

12.3.3(c) Post the Code of Safe Practices at a conspicuous location at each job site office or provide it to each supervisory employee, who shall have it readily available

12.3.3(d) Hold periodic meetings of supervisory employees under the direction of management for the discussion of safety problems and accidents that have occurred

12.3.3(e) Conduct "toolbox" or "tailgate" safety meetings, or equivalent, with crews at least every 10 working days to emphasize safety. These meetings are to be conducted by supervisory personnel, and meeting rosters containing attendee names and the meeting topic must be readily available to CSD.

12.3.3(f) Perform an assessment of each job site to identify existing and potential health and safety concerns affecting worker safety.

12.3.3(g) Follow the Deferral and Referral Policy when applicable.

12.4. HazCom Program Requirements

12.4.1 Hazardous substances that require a HazCom program are:

12.4.1(a) Any substance that is a physical or a health hazard or

12.4.1(b) Any listed hazardous substance

12.4.2 All agencies and subcontractors are required to have a written HazCom program in place. The HazCom program must include:

12.4.2(a) A procedure for the employer to inform workers of all hazardous substances to which they are exposed at the job site.

12.4.2(b) A list of the hazardous substances that are used or stored in the workplace.

12.4.2(c) Readily accessible safety data sheets (SDS) for each substance/chemical

12.4.2(c1) Labels and other forms of warning on containers of hazardous substances

12.4.2(c2) Procedures for safe handling, use, storage, disposal, and clean-up to protect employees

12.4.2(d) Training on the hazardous substances that employees are or could be exposed to in the workplace

12.4.2(e) A plan for managing multi-employer worksite issues

12.4.2(f) A plan to periodically evaluate program effectiveness and to update the program

12.4.3 Requirements for developing, implementing, and maintaining a HazCom program are found in CCR Title 8, Section 5194. Subsection 5194(b)(6) contains the Safe Drinking Water and Toxic Enforcement Act (Proposition 65), which was added to the original HazCom regulation in 1991.

12.4.4 For the HazCom Program, agencies/subcontractors are required to:

12.4.4(a) Provide employees with effective information and training on hazardous chemicals in their work area at the time of their initial assignment and whenever a new chemical hazard is introduced into their work area.

12.4.4(b) Obtain SDS copies that include information such as health hazards, special chemical and physical characteristics, protective measures, and precautions for safe handling, use, and storage of each chemical. The SDS may change over time; therefore, SDSs should be updated annually to ensure that employees are provided with the most current versions.

12.4.4(c) Disseminate SDS. A complete SDS set for all materials used and encountered on the job must be kept on file at the central office and in every vehicle used by personnel performing weatherization work for the agency. SDS copies also shall remain at the job site for the duration of all work to ensure that all employees have immediate access to the safety information.

12.4.4(d) Clearly label storage containers of hazardous materials to identify the contents and to show appropriate hazard warnings for employee protection.

12.5. Respirator Protection Program (RPP)

12.5.1 The employer (agency or subcontractor) is required to assess the workplace for respiratory hazards and to determine the type of respiratory protection that will be required to meet the health needs of workers. (See Table E-10.) An SDS may also describe the respirator type and filtration needed to safely work with the material; however, it shall not be the only determinant. If the decision is made that no respiratory hazards exist and the use of respirators is not required, workers may voluntarily use a respirator.

12.5.2 Given the nature of weatherization work, the use of a respirator by workers may be a necessity for worker health and safety. However, improper and inappropriate use of respirators can result in worker injury and death. Agencies that provide them to their workers must comply with CCR Title 8 Section 5144 and have a written RPP in place.

12.5.2(a) The written RPP must include the agency's/subcontractor's procedure for:

12.5.2(a1) Respirator selection

12.5.2(a2) Medical evaluations

12.5.2(a3) Fit testing

12.5.2(a4) Use of respirators

12.5.2(a5) Maintenance and care of respirators

12.5.2(a6) Breathing air quality and use

12.5.2(a7) Training and information

12.5.2(a8) Program evaluation

12.5.3 Before issuing respirators, workers must be:

12.5.3(a) Medically assessed to make sure they can wear a respirator without experiencing breathing problems

12.5.3(b) Fit-tested for the respirator type

12.5.3(c) Trained in the proper care and use of respirators

12.5.4 Everything that can be done to reduce or eliminate the need for a respirator must be done before respirators are issued or required to be worn by workers. This means that work practices, engineering controls, and administrative practices must be used, when feasible, before the need for a respirator is determined.

Table E-10: Selection of Proper Respiratory Protection by Exposure Type*		
Material/Chemical	**Required Filtration**	**Type of Respirator**
• Lead-based paint dust • Asbestos	• -100 series particulate filters (P, N, R)	• Half-face air-purifying respirator
• Fiberglass • Cellulose • Dusts	• -97 or -95 particulate filters (P, N, R)	• Half-face air-purifying respirator or filtered face piece (dust mask)
• Hydrocarbons (solvents, cleaners, etc.) • Odors	• Charcoal filtered*	• Half-face air-purifying respirator
• Unidentified particulates	• -100 series particulate filters (P, N, R)	• Half-face air-purifying respirator
• Unidentified odors and gasses	• Defer—possible IDLH** situation	• Full face, pressure demand, self- contained breathing apparatus (SCBA)
• Low-pressure, two-component, spray polyurethane foam (SPF)*	• Organic vapor cartridge and P-100 particulate filter	• Half-face air-purifying respirator
• High-pressure SPF insulation*		• Supply air respirator (SAR)
*Check SDS for filtration requirements first. **Immediately Dangerous to Life and Health		

12.6. Agency/Subcontractor Recordkeeping

12.6.1 Records pertaining to Cal/OSHA-required worker-hazardous material exposure (i.e., exposure limits and medical testing as defined in Title 8, Chapter 4) shall be filed at an Agency's main office. Cal/OSHA standards concerning toxic substances and hazardous exposures require records of employee exposure to these substances and sources, physical examination reports, employment records, and other information.

12.6.2 CSD also requires that presence of hazardous materials encountered during a dwelling assessment must also be documented within the following program forms and stored in the client's permanent file:

12.6.2(a) CSD 540 CSD Dwelling Assessment Form

12.6.2(b) CSD 540A Weatherization Mold/Moisture Assessment and Release Form

12.6.2(c) CSD 542 Weatherization Deferral Form

12.6.2(d) CSD 611 Contractor Post-Weatherization Inspection Report

12.6.2(e) CSD 700 Combustion Appliance Safety Inspection Form (CASIF) series

12.6.2(f) CSD 704 Shell Leakage Data Sheet

12.6.2(g) CSD 706 Duct Leakage Data Sheet

12.6.2(h) CSD 708 Lead-Based Paint Regulatory Compliance Report

12.6.3 Workplace accident information shall be collected and stored for at least the previous 5 years in accordance with Cal/OSHA requirements as defined here: http://www.dir.ca.gov/dosh/etools/recordkeeping/index.html.

12.6.4 Any inspection of jobsite or workplace by Cal/OSHA or CSD may require that agencies or subcontractors demonstrate the effectiveness of their program procedures.

13. HEALTH AND SAFETY TRAINING REQUIREMENTS FOR WORKERS

13.1 Weatherization agencies and their subcontractors are responsible for providing health and safety training for field personnel. All field personnel (assessors, installers, and inspectors) shall participate in health and safety training and follow established safety practices. A health and safety training program shall be designed and implemented to provide:

13.1.1 All new employees with training before they enter the field for the first time, and

13.1.2 All employees with regular periodic training

13.2 When an unfamiliar working condition is encountered for the first time, a safety meeting shall be held on the first day of work to cover all new conditions/hazards and applicable safety procedures.

13.3. Tailgate Safety Meetings

13.3.1 Because of the wide range of activities involved in weatherizing a house, tailgate meetings shall cover a broad range of appropriate Cal/OSHA topics and requirements. Some of these requirements include, but are not limited to:

13.3.1(a) Personal protective equipment (PPE)

13.3.1(b) Techniques for safely lifting heavy objects

13.3.1(c) Hand and power tool safety

13.3.1(d) Slips, trips, and falls safety training

13.3.1(e) Electrical equipment safety

13.3.1(f) Ladder safety

13.3.1(g) General worker protection

13.3.1(h) Safety data sheets

13.3.2 A meeting agenda and/or minutes shall be kept to document (1) the date and location of training, (2) synopsis of subject matter covered, and (3) the names of participants. Signatures of persons in attendance shall be included. These agendas and sign-in sheets shall be kept on file at the agency and with CSD, and all safety records are subject to review by CSD staff upon request.

13.3.3 The safety program shall include periodic evaluations by agencies to determine its effectiveness, with the evaluations being used to improve the program.

13.4. OSHA-10 and OSHA-30 Training Requirement

13.4.1 CSD requires that field workers and supervisors complete standardized safety training programs, in conjunction with OSHA and the Department of Labor.

13.4.2 These programs—either the entry-level 10-Hour OSHA Safety Training for Construction, or the 30-Hour Training for supervisors/competent persons—provide a general safety background for workers in the construction industry. These courses may be completed on-line or via in-person training, but are required to result in an “OSHA card” following course completion.

13.5. Lead-Safe Weatherization Training Requirements

13.5.1 CSD requires that all weatherization employees of agencies and subcontractors are required to be trained in lead-safe weatherization practices using CSD-approved training materials or workshops. This training shall be provided through a CSD-approved training center or representative, utilizing CSD-approved training curriculum. Training coursework shall be successfully completed.

13.5.2 Field personnel will not be allowed to enter, assess, weatherize or inspect a unit until they have completed required lead-safe weatherization training.

13.5.2(a) U.S. EPA Lead Renovation, Repair and Painting Program

13.5.2(a1) At least one individual at each agency/subcontractor (who may disturb paint) is required to be an EPA Certified Renovator. Certified Renovators must be trained and certified through an EPA-accredited training provider before an existing certification expires.

13.5.2(a2) Agencies/subcontractors will be required to provide documentation of each Certified Renovator's credentials to perform the specific functions of that role.

13.5.2(a3) State monitors/inspectors shall also receive the training and be EPA "certified renovators." This ensures quality control and procedures being performed on the homes are in accordance with EPA requirements.

13.5.2(b) CDPH Lead-Related Training

13.5.2(b1) CDPH Lead-Related Construction certification is not required however, anyone wishing to become a state-certified lead dust sample technician, paint inspector/risk assessor, supervisor, monitor, or worker are required to be trained by a state Department of Public Health–accredited training provider.

13.5.2(c) HUD Lead-Safe Training

13.5.2(c1) For weatherization services performed on HUD units, the EPA's RRP Rule certification and training requirements apply.

13.5.2(d) Department of Energy Lead-Safe Training

13.5.2(d1) For weatherization services performed on DOE units, the EPA's RRP Rule certification and training requirements apply.

13.6. Training Records

13.6.1 Agencies/subcontractors are required to maintain training records for current employees, including all lead-safe training completed.

13.6.2 The training log shall contain the employee name, type of training received, date(s) of training, date of certification (if received), certification expiration date, and copy of training certificate.

13.6.3 The training log for each agency/subcontractor shall be maintained in each agency's central file system and shall be made available for review by CSD upon request.

F. Multi-Family Standards

Table of Contents

1. OVERVIEW

When weatherizing a multi-family whole-building project (of 5 or more units) with common heating and/or cooling systems, this Multi-Family Standards document will apply in conjunction with the Multi–family Specific section for each measure included in the project work scope. Both in-unit and common area measures are addressed by these standards.

These standards apply to multi-family (5+ units) whole building projects under the Department of Energy (DOE) Low-Income Weatherization Assistance Program and Low-Income Home Energy Assistance Program (LIHEAP).

In cases where a conflict exists between these policies and the local code described in the CSD Technical Reference Manual (TRM) for an individual measure, the TRM and local code shall supersede for the multi-family whole-building project.

Where a measure is not addressed in this Multi-Family Standard, the conventional home (single-family unit) installation requirements shall be the sole guidance.

The contents of the multi-family standards are divided into six sections:

2. Health and Safety
3. Air Sealing
4. Insulation
5. Heating and Cooling
6. Ventilation
7. Baseload (Electric and Gas)

Each section is then divided into smaller topics and, finally, into the policy, which appears with a bullet (•). There may be multiple policies for each sub-section. Questions about these policies or their interpretation should be made to CSD using the Technical Hotline at (877) 831-7596 or by email at Wx.Hotline@csd.ca.gov.

2. HEALTH AND SAFETY

2.0100 Safe Work Practices

This section applies to the installation of all multi-family, whole-building measures.

2.0100 Worker Safety Practices

2.0100.1 Global Worker Safety

2.0100.1a Prevention through design

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

2.0100.1b Hand protection

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

2.0100.1c Respiratory protection

- If the risk of airborne contaminants cannot be prevented, proper respiratory protection will be provided and worn (e.g., N-95 or equivalent face mask)
- When applying low pressure 2-component spray polyurethane foam, air purifying masks with an organic vapor cartridge and P-100 particulate filter will be used
- When applying high-pressure SPF insulation, supplied air respirators (SARs) will be used
- Consult SDS for respiratory protection requirements
- CalOSHA PPE policies shall be followed for the implementation of a respiratory protection program

2.0100.1d Electrical safety

- An electrical safety assessment will be performed
- All electric tools will be protected by ground-fault circuit interrupters (GFCI)
- Three-wire type extension cords will be used with portable electric tools
- Worn or frayed electrical cords will not be used
- Water sources (e.g., condensate pans) and electrical sources will be kept separate
- Metal ladders will be avoided
- Special precautions will be taken if knob-and-tube wiring is present
- Aluminum foil products will be kept away from live wires
- For arc flash hazards, NFPA 70E will be consulted

2.0100.1e Carbon monoxide (CO)

- All homes will have a carbon monoxide alarm
- Ambient CO will be monitored during combustion testing and testing will be discontinued if the ambient CO level inside the home or workspace exceeds 35 parts per million (ppm)

2.0100.1f Personal Protective Equipment

- Safety Data Sheets and CalOSHA regulations will be consulted for equipment and protective clothing would be worn if contaminants are present (e.g., insulation materials)

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

2.0100.1g Confined space safety

- Spaces with limited ingress and egress and restricted work area will be considered confined space
- Access and egress points will be located before beginning work
- Inspection will be conducted for hazards, such as damaged or exposed electrical conductors, mold, sewage effluent, friable asbestos or fiberglass, pests, and other potential hazards
- Adequate ventilation will be provided
- Use of toxic material will be reduced

2.0100.1h Power tool safety

- Power tools will be inspected and used in accordance with manufacturer specifications and CalOSHA regulations to eliminate hazards such as those associated with missing ground prongs, ungrounded circuits, misuse of power tools, noise, and improper or defective cords or extension cords. All tools must be maintained in proper operating condition with all guards securely in place
- All devices used will be verified as GFCI protected or double insulated
- Exhaust gases from compressors and generators will be prevented from entering interior space

2.0100.1i Chemical safety

- Hazardous materials will be handled in accordance with manufacturer specifications, Safety Data Sheets (SDS) and CalOSHA standards to eliminate hazards associated with volatile organic compounds (VOCs), sealants, insulation, contaminated drywall, dust, foams, asbestos, lead, mercury, and fibers
- Appropriate personal protective equipment (will be provided
- Workers will be trained on how to use Personal Protective Equipment (PPE)
- Workers will be expected to always use appropriate PPE during work

2.0100.1j Ergonomic safety and PPE

- Appropriate PPE will be used (e.g., knee pads, bump caps, additional padding)
- Proper equipment will be used for work
- Proper lifting techniques will be used

2.0100.1k Hand tool safety

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

2.0100.1l Slips, trips, and falls

- Caution will be used around power cords, hoses, tarps, and plastic sheeting
- Precautions will be taken when ladders are used, when working at heights, or when balancing on joists
- Walk boards will be used when practical
- When scaffolding is used, manufacturer set-up procedures will be followed
- Appropriate footwear and clothing will be worn

2.0100.1m Thermal stress

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

- Appropriate ventilation, hydration, rest breaks, and cooling equipment will be provided
- 911 will be dialed when necessary

2.0100.1n Fire safety

- Ignition sources will be identified and eliminated (e.g., turn off pilot lights and fuel supply)
- Use of flammable material will be reduced and fire-rated materials will be used

2.0100.1o Asbestos-containing materials (ACM)

- Assess potential asbestos hazard; if unsure whether material contains asbestos, contact a qualified asbestos professional to assess the material and to sample and test as needed
- If suspected ACM is in good condition, do not disturb
- If suspected ACM is damaged (e.g., unraveling, frayed, breaking apart), immediately isolate the area(s) and contact the work supervisor to determine next steps
- When working around ACM, do not:
  - Dust, sweep, or vacuum ACM debris
  - Saw, sand, scrape, or drill holes in the material
  - Use abrasive pads or brushes to strip materials

2.0100.1p Lead paint assessment

- Presence of lead based paint in pre-1978 homes will be assumed unless testing by a California Department of Public Health-certified Inspector/Assessor written verification confirms otherwise
- The Environmental Protection Agency (EPA) Renovation, Repair, and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

2.0100.1q Site security

- Work site will be secured to prevent unauthorized entry
- Temporarily disconnected equipment will be locked up and tagged out
- All loose or un-bagged trash and unused materials will be removed from work site daily

2.0100.1r Crawlspace area safety

- The source of all contaminants (e.g., sewage, dead animals, needles) will be corrected, repaired, or removed before performing inspections that require complete access to the crawlspace
- If appropriate, the contaminant will be neutralized and/or a protective barrier will be installed in the area

2.0100.2 Work Area Inspection and Stabilization

2.0100.2a Inspect to confirm integrity of existing building assembly

- An inspection will be conducted for existing conditions that may hinder successful installation of proposed energy improvement

2.0100.2b Identify hazardous construction materials that may be disturbed or compromised by proposed work

- The inspection will include determination of the presence of known or presumed hazardous construction materials, including lead paint, asbestos, and in the case of window replacement, caulk, which may contain polychlorinated biphenyls
- Where proposed work can be performed without disturbing suspect materials or under conditions consistent with applicable codes and regulations, a presumption of the presence of hazardous construction materials may be made without actual testing where such testing is not an integral part of the work to be performed

2.0100.2c Identify environmental conditions that may create or worsen unsafe or unstable building assembly conditions

- The inspection will include determination of the presence of adverse environmental conditions, including excess moisture in contact with building assemblies, mold, wood-decaying fungi, and rodent or insect infestation
- A visual inspection of exposed electrical wires, junction boxes, and related equipment will be made to identify any unsafe conditions
- Where insulation materials will be delivered into closed cavities, evaluation of wiring types within such cavities will be conducted to determine if proposed insulation application is compatible with current performance characteristics of wiring (e.g., wiring types that present a fire hazard when in close contact with insulation materials, wiring types subject to corrosion when in contact with certain types of insulation or which may be adversely affected by heat, moisture, or process conditions associated with the installation of certain insulation types)

2.0100.2d Address and correct hazardous or adverse conditions

- Where excess moisture conditions are identified where their correction is not included in proposed work, such conditions will be corrected before work begins

2.0101 Worker Safety—Air Sealing

2.0101.1 Air Sealing Worker Safety

2.0101.1a Worker safety

- Worker safety specifications will be in accordance with Global Worker Safety
- Complete safety action plan based on hazard; plan will be in place for each job site

2.0101.1b Moisture precautions for crawlspaces and basements

- Exposed earth will be covered with a continuous, durable, and sealed with a Class I vapor retarder when required by the local jurisdiction that is suitable for ground contact exposure to normal service traffic
- Holes between the crawlspace or basement, and the living space, will be sealed

2.0101.1c Moisture precautions: living space

- Moisture sources in the building will be identified and reduced or removed
- Where local ventilation will be installed, (e.g., baths, kitchens), exhaust units will be vented to the outdoors in accordance with ASHRAE 62.2
- Unvented heaters will be removed except when used as a secondary heat source and when it can be confirmed that the unit is listed to ANSI Z21.11.2
- Unvented gas or propane cooking stoves will be tested for carbon monoxide per the BPI 1200 Standard and corrected as required before air sealing work begins
- ANSI/ACCA 2 Manual J-2011 Residential Load Calculation will be used to size replacement AC and heat pumps

2.0101.1d Moisture precautions for exterior water

- Before air sealing and insulating building components, exterior water management will be addressed when allowed under weatherization
- Before insulating basement or crawlspace walls near wet areas, surface water pooling near the foundation will be addressed by repairing, modifying, or replacing gutters and downspouts

2.0102 Worker Safety—Insulation

2.0102.1 Insulation Worker Safety

2.0102.1a Worker safety

- Worker safety specifications will be followed in accordance with Global Worker Safety

2.0102.1b Asbestos containing materials (ACM)

- The CSD Asbestos Policy in Appendix E Health and Safety Requirements shall be followed in all cases where ACMs are identified

2.0102.1c Materials

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

2.0102.1d Lead paint assessment

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

2.0103 Worker Safety—Heating and Cooling Equipment

2.0103.1 Combustion Worker Safety

2.0103.1a Worker safety

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

2.0103.1b Carbon monoxide (CO)

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

2.0103.1c Raw fuel

- Raw fuel leaks will be monitored for before entering building spaces
- If leaks are found, testing will be discontinued, and condition reported to occupant immediately

2.0103.2 Heating and Cooling Worker Safety

2.0103.2a Worker safety

- All worker safety specifications in Global Worker Safety shall apply

2.0103.2b Mercury

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

2.0103.2c Asbestos

- The CSD Asbestos Policy in Appendix E Health and Safety Requirements shall be followed in all cases where ACMs are identified
- Suspected asbestos hazards will be identified in furnaces (e.g., gaskets), wood stoves, zonal heating devices, electrical wiring insulation, boilers, and pipe insulation
- Workers will take precautionary measures to avoid exposure

2.0103.2d Personal protective equipment (PPE)

- Workers will wear personal protective equipment (PPE) as needed to protect themselves against exposure to hazards (e.g., pests, sewage, flooded duct work, mold, chemicals, scat, viruses)
- Long sleeves and long pants should be worn as additional protection from liquid nitrogen and other hazardous materials

2.0103.2e Combustible gas detection

- Worker will check for presence of combustible gas leaks before work begins
- Leaks will be repaired before work is performed

2.0103.2f Carbon monoxide (CO)

- Workers will check for presence of ambient CO before and during work
- CO issues will be addressed before work is performed or continued

2.0103.2g Sealant

- Pipes will be sealed by a certified professional with an approved fastening process and sealant in accordance with manufacturer specifications (International Fuel Gas Code)
- Gas lines will be leak free when tested with an electronic combustible gas leak detector and verified with bubble solution or standing pressure test that meets the approval of the local code

2.0103.2h Safety devices

- A secondary LP safety detector system (valve, exhaust fan, alarm light) will be installed by a certified professional for propane piping installed below grade
- When installing new equipment, a shut-off valve will be installed by a certified professional at each gas appliance (ANSI Z21.15)

2.0104 Worker Safety—Ventilation Equipment

2.0104.1 Ventilation Worker Safety

2.0104.1a Worker safety

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

2.0105 Worker Safety—Baseload Measures

2.0105.1 Baseload Worker Safety

2.0105.1a Worker safety

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

2.0105.2 Licensed Electrical Professional

2.0105.2a Electrical worker safety

- Any fixture, ballast, line voltage control, receptacle, or circuit modification will be performed by a licensed electrical professional in accordance with ANSI/NFPA 70 or as required by the authority having jurisdiction
- All workers will comply with the ANSI/NFPA 70E standard
- All CalOSHA standard practices will be followed

2.0106 Worker Safety—Material Selection

2.0106.1 Material Selection, Labeling, and Safety Data Sheets (SDS)

2.0106.1a Material selection

- Materials that do not create long-term health risks for occupants and workers will be used

2.0106.1b Material labels

- Manufacturer specifications will be followed

2.0106.1c Safety Data Sheets (SDS)

- SDS will be provided onsite and available during all work

2.0106.2 Potential Asbestos-Containing Materials (ACM)

2.0106.2a Determine if testing is necessary

- Existing insulation will be visually inspected without disturbing the material and evaluated for suspicion of asbestos-containing materials
- Property manager will be asked about known history of insulation
- Property manager will be informed of potential for additional testing if history is unknown

2.0106.2b Asbestos containing material (ACM) environmental testing

- If ACM may be present, educate property manager for need of testing
- Removal by a licensed abatement contractor must be completed and documented for areas to be impacted by weatherization before any proposed weatherization work may be completed

2.0106.2c Asbestos removal

- Property manager will arrange for asbestos removal by an asbestos professional in accordance with federal, state, and local requirements. Only a licensed or trained professional may abate, repair, or remove ACM
- Third-party air monitoring during abatement work will be provided in accordance with federal, state, and local requirements

- At end of abatement process, documents will be provided to the property manager by the contractor that states ACMs were removed in accordance with all applicable federal, state, and local requirements, and no ACMs are present in the work area

2.0107 Worker Safety—Basements and Crawlspaces

2.0107.1 Basements and Crawlspaces

- Safety specifications in Crawlspace area safety will be followed

2.0200 Worker Safety—Combustion Safety

Safety specifications in Combustion Worker Safety and within each measure of the Multi-Family Weatherization TRM shall apply as specified. Where procedure is not defined specifically in this section, Appendix A Combustion Appliance Safety Protocol shall apply.

2.0201 Combustion Safety (General)

Not defined specifically for multi-family whole-building projects.

2.0202 Unvented Space Heaters

Not defined specifically for multi-family whole-building projects.

2.0203 Vented Gas Appliances

2.0203.3 Combustion Air—Boilers

2.0203.3a Combustion air

- Combustion air shall be calculated and provided in conformance with the applicable code adopted by the jurisdiction and manufacturer requirements
- In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply (i.e., more air rather than less)
- In absence of a local code, combustion air shall be calculated and provided in conformance with NFPA 54, IFGC, or NFPA 31
  - Exception: Existing appliances that have passed combustion safety testing using the procedures of BPI 1200 are deemed to have sufficient combustion air

2.0203.3b Client education

- Property manager/occupant will be educated on proper operation of combustion air systems

2.0204 Isolation of Air

2.0204.1 Isolating Combustion Water Heater Closet

Not addressed in the Multi-Family Weatherization TRM specific to multi-family dwellings. The Appendix A Combustion Appliance Safety Protocol policies shall be applicable.

2.0204.2 Isolating Combustion Appliance Rooms (e.g., Boiler Room, Furnace Room, and Generator Room)

2.0204.2a Pre-inspection

- Hazardous materials stored in mechanical rooms with air handlers or combustion appliances (e.g., boilers, furnaces) will be identified and removed; operators will be educated on the dangers of storing hazardous materials in these areas
- Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins
- Mechanical room doors in a fire-rated wall will be closed; problems that cause doors to be blocked open will be determined and resolved

2.0204.2b Identification of penetrations

- Penetrations will be identified using visual inspections, infrared thermography, smoke, and/or pressure tests [ASTM Standard E1186-03 (2009)]

2.0204.2c Preparation of Area

- Health and safety concerns will be addressed for occupants, workers, and repair materials in accordance with CalOSHA Title 8, Subchapters 4, 7
- The area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos, carbon monoxide)
- Work lighting, work platform, and adequate ventilation will be provided

2.0204.2d Sealant and materials selection

- Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications
- Selection will be durable, pest resistant, and have a weather-appropriate seal
- See Selection of All Sealants
- Sealants and materials will be continuous and meet fire resistance rated assembly specifications installed in conformance with local code

2.0204.2e Verification

- Repairs will be verified using visual inspections, infrared thermography, smoke, and/or pressure tests (ASTM E1186-03 (2009)

2.0205 Gas and Oil-Fired Equipment

2.0205.1 Gas and Oil-Fired Equipment

2.0205.1a Combustion air

- Combustion air shall be calculated and provided in conformance with the applicable code adopted by the jurisdiction, and manufacturer installation requirements
- In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply
- In absence of a local code, combustion air shall be calculated and provided in conformance with NFPA 54, IFGC or NFPA 31

2.0205.1b Installation

- Venting systems will be installed considering proper material, pitch, common venting, chimney liner, clearance, total equivalent length, and termination in accordance with the applicable code adopted by the jurisdiction and manufacturer installation requirements

- In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply
- In absence of local code, combustion byproducts shall be removed in accordance with NFPA 54, IFGC or NFPA 31

2.0205.1c Orphaned equipment

- When orphaned equipment exists, the existing vent system or chimney will be resized or relined in accordance with the applicable code adopted by the jurisdiction when one or more common vented appliances are removed
- In absence of local code, combustion byproducts shall be removed in accordance with NFPA 54, IFGC or NFPA 31

2.0300 Safety Devices

Where not addressed by the Multi-Family Weatherization TRM, the Appendix E Health and Safety Requirements policies shall be applicable.

2.0301 Combustion Safety Devices

2.0301.1 Smoke Alarm

2.0301.1a Smoke alarm (hardwired)

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

2.0301.1b Smoke alarm (battery operated)

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

2.0301.2 Carbon Monoxide Alarm

2.0301.2a Carbon monoxide detection and warning equipment (hardwired)

- Hardwired detection and warning equipment will be installed in accordance with the ASHRAE 62.2 or as required by the authority having jurisdiction
- Installation will be accomplished by a licensed electrician when required by the authority having jurisdiction

2.0301.2b Carbon monoxide detection and warning equipment (battery operated)

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

2.0302 Cooling Equipment

2.0302.1 Locking Refrigerant Caps—Mid and High Rise

2.0302.1a Installing refrigerant locking caps

- Where required by code, locking refrigerant caps will be installed on the refrigerant access ports

2.0400 Moisture

Where not addressed by the Multi-Family Weatherization TRM, the Appendix E Health and Safety Requirements policies shall be applicable.

2.0401 Air Sealing

2.0401.1 Air Sealing Moisture Precautions

2.0401.1a Moisture precautions: attics/roofs

- Roof leaks will be repaired before performing attic air sealing or insulation
- Moisture sources in the house that can generate moisture into the attic will be identified and removed or reduced

2.0401.1b Moisture precautions for crawlspaces

- Exposed earth will be covered with a continuous, durable, sealed Class 1 vapor retarder a minimum of 6 mils in thickness
- Any vapor retarder shall not encapsulate wood building materials or spray foam
- Holes between the crawlspace and the living space will be sealed

2.0401.1c Moisture precautions for the living space

- Moisture sources in the home will be identified and removed or reduced
- Local ventilation will be installed where appropriate (e.g., baths, kitchens) and vented to outside according to ASHRAE 62.2
- Unvented combustion appliances that are not listed to ANSI Z21.11.2 will be removed

2.0401.1d Moisture precautions for exterior water

- Before air sealing basement or crawlspace walls near wet areas, surface water pooling near the foundation must be addressed by repairing, modifying, or replacing gutters and downspouts

2.0402 Drainage

Where not addressed by the Multi-Family Weatherization TRM, the Appendix E Health and Safety Requirements policies shall be applicable.

2.0403 Vapor Barriers

Where not addressed by the Multi-Family Weatherization TRM, the Appendix E Health and Safety Requirements policies shall be applicable.

2.0404 Space Conditioning

Where not addressed by the Multi-Family Weatherization TRM, the Section 4 Heating and Cooling policies shall be applicable.

2.0500 Radon

Due to radon testing certification requirements from the state of California Department of Public Health, CSD does not allow testing or mitigation of radon within its weatherization programs. In areas of high radon risk or where radon exposure is suspected, infiltration reduction measures may be deferred.

2.0502 Testing & Evaluation

2.0502.1a Radon Testing—Program Variance

- Testing policies for multi-family buildings not applicable within California's Program due to state regulations for radon testing and abatement certifications

2.0600 Electrical Safety

Electrical safety specifications will be followed in accordance with Electrical Safety. Where not addressed by the Multi-Family Weatherization TRM, the Appendix E Health and Safety Requirements policies shall be applicable.

2.0700 Required Client Education & Building Access

2.0701 Access to Basements and Crawlspaces

Where not addressed by the Multi-Family Weatherization TRM, the Section 1 General Installation Guidelines and measure-specific policies pertaining to client education shall be applicable.

2.0702 Client Education for Installed Equipment

2.0702.2 Occupant Education

2.0702.2a System operation

- Basic operation of the equipment will be explained to the building operations staff (e.g., design conditions, efficiency measures, differences from previous system or situation)

2.0702.2b System controls (e.g., thermostat, humidistat)

- Proper operation and programming of system controls to achieve temperature and humidity control will be explained to the occupant and provided in a written format

2.0702.2c System disconnects

- Indoor and outdoor electrical disconnects and fuel shut-offs will be demonstrated to occupant

2.0702.2d Combustion air inlets

- Location of combustion air inlets will be identified for occupant
- Importance of not blocking inlets will be explained to occupant

2.0702.2e Blocked airflow

- Importance of cleaning dust and debris from return grilles will be explained to occupant
- Proper placement of interior furnishings with respect to registers will be explained to occupant
- Negative consequences of closing registers will be explained to occupant
- Occupant will be educated on the importance of leaving interior doors open as much as possible

2.0702.2f Routine maintenance

- Proper filter selection and how to change filter will be explained to building operations staff

- Importance of keeping outdoor unit clear of debris, vegetation, decks, and other blockage will be explained to building operations staff
- Importance and timing of routine professional maintenance will be explained to building operations staff, e.g. inspect, clean, lubricate, replace consumables (i.e., filters, belts, lights), repair and replace

2.0702.2g Occupant service requests

- Appropriate situations of when the occupant should contact the building operations staff will be explained, including:
  - Fuel odors
  - Water draining from secondary drain line
  - Emergency heat indicator always on for a heat pump system
  - System blowing cold air during heating season and vice versa
  - Icing of the evaporator coil during cooling mode
  - Outdoor unit never defrosts
  - Unusual noises
  - Unusual odors

2.0702.2h Carbon monoxide and client education (CO)

- Client will be informed about CO alarm function and operation

2.0702.2i Warranty and service

- Building operations staff/property manager will be provided with relevant manuals and warranties
- The labor warranty will be explained, and the building operations staff will be given a phone number to call for warranty service

2.0702.3 Building Manager Education

2.0702.3a Systems operation, maintenance, and sustainability

- Operation of the equipment maintenance will be explained to the building manager/ operations staff (e.g., design conditions, efficiency measures, differences from previous system or situation)
- Operation and maintenance manual will be provided and updated to building manager

2.0702.3b System controls (e.g., thermostat, humidistat)

- Building operations staff will be educated on the sequence of the building systems and their controls

2.0702.3c System disconnects

- Indoor and outdoor electrical disconnections and fuel shut-offs will be demonstrated to building operations staff

2.0702.3d Combustion safety awareness

- Location of combustion air inlets and gas vents will be identified for building operations staff
- Importance of not blocking inlets will be explained to building operations staff
- Building operations staff will understand that flammable material will not be stored in the combustion appliance zone

2.0702.3e System airflow

- Importance of cleaning dust and debris from returns grilles will be explained to building operations staff
- Proper placement of interior furnishings with respect to registers will be explained to building operations staff
- Negative consequences of closing registers will be explained to building operations staff
- Importance of leaving interior doors open as much as possible will be explained to building operations staff

2.0702.3f Routine maintenance

- Proper filter selection (i.e., minimum MERV 6 (rating) and how to change filter will be explained to building operations staff
- Importance of keeping outdoor unit clear of debris, vegetation, decks, and other blockages will be explained to building operations staff
- Importance and timing of routine professional maintenance will be explained to building operations staff, e.g., inspect, clean, lubricate, replace consumables (i.e., belts, filters), repair and replace

2.0702.3g Occupant service requests

- Situations when the occupant should contact the building operations staff will be explained, including:
  - Fuel odors
  - Water draining from secondary drain line
  - Emergency heat indicator always on for a heat pump system
  - Thermal comfort issues
  - Unusual noises
  - Unusual odors
- Building operations staff will be informed of situations where they must call outside resources:
  - Flooding
  - Odors
  - Electrical issues

2.0702.3h Carbon monoxide (CO) alarm and education for building operations

- Building operations staff will be educated on function, location, operation, and service of alarm

2.0702.3i Warranty and service for building operations staff

- Building operations staff/property manager will be provided with relevant manuals and warranties
- Labor warranty will be explained and the building operations staff/property manager will be given a phone number to call for warranty service

7.8103.6 Operations Manual for Multi-Family Projects

The following item from 2017 SWS 7.8103.6 is amended and will be applied to all measures installed in a multi-family whole building project.

7.8103.6a Operation manual

- An operation manual shall be provided to the building manager that details of pre-inspection results, installation work, and recommended maintenance of all affected systems will be provided to the building manager to facilitate education

- The operation manual for the multi-family project will have a table of contents, will be tabbed, and presented in a ringed binder

7.8103.6b Operation binder content

- Operation manual will include information on:
  - Recommended safety considerations
  - Installer contact details
  - Measure/equipment warranties
  - Manufacturer specifications for equipment and components
  - Operational instructions
  - Maintenance recommendations
- Installers will include any pertinent sections
- Example of binder sections for a replaced water heater:
  - Equipment installed
  - Safety considerations
  - Operational instructions
  - Measure/equipment warranties
  - Hot water system
  - Hot water source: Boilers, storage water heater, or tankless water heater(s)
  - Components parts also installed
  - Storage/expansion tanks
  - Pumps
  - Piping
  - Materials
    - Location
    - Pipe tracing
    - Valves
  - Controls
    - Safety
    - Operational
    - Recirculation
  - Sensors
  - Gauges
  - Combustion venting
  - Wiring
  - Insulation

3. AIR SEALING

Multi-Family Weatherization TRM policies for air sealing shall be applied. Where certain air sealing activities are not described in this section, the Section 32 Infiltration Reduction and measure-specific policies pertaining to air sealing shall be applicable.

3.0000 Air Sealing Materials

3.0001 Selection of All Sealants

3.0001.a Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications

3.0001.b Selection will be durable, pest resistant, and have a weather-appropriate seal

3.0001.c Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications

3.0001.d Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code

3.0002 Backing and Infill

3.0002.a Where gaps, cracks, or holes are larger than ¼" across and/or where the air sealing materials will be subject to temperature variations in excess of 50° F, the need for backing or infill will be evaluated

3.0002.b If used, backing or infill will meet specific characteristics of the fire-resistance-rated assembly, and be compatible with the characteristics of the gap, crack, or hole, including preservation of any expansion/contraction characteristics for assembly (e.g., expansion joints, steam pipes, or dissimilar material interfaces with differing coefficients of expansion)

3.0002.c Backing or infill will be selected that maintains sealant placement and durability while allowing for the expected movement from expansion, contraction, load deflection, settling at the location, or if existing water control measures are compromised (e.g., rain screen, drip edge, weep holes, gutter and roof drains, scuppers, or other exterior water management elements)

3.1000 Air Sealing Attics

3.1001 Attic Penetrations and Chases

3.1001.5 Air Sealing in Attic Penetrations and Chases

3.1001.5a Pre-inspection of attic

- Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces
- Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating

- Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single ⅝" sheetrock, concrete masonry unity), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating

3.1001.5b Backing and infill

- See Backing and Infill

3.1001.5c Sealant selection

- See Selection of All Sealants

3.1001.5d High temperature sealant applications

- Only noncombustible sealant will be used in contact with chimneys, vents and flues, or any heat source (e.g., non-IC [insulation contact] rated recessed lights, heat lamps, etc.)
- Sealant application at factory-built vents, flues, and chimneys shall be listed for use with that vent assembly

3.1001.6 Air Sealing in Firewall of an Unconditioned Attic

3.1001.6a Pre-inspection of firewall in unconditioned attics

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization
- Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces
- Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating
- Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single ⅝" sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating
- Air sealing locations will be identified between the firewall and the attic floor

3.1001.6b Backing and infill

- See Backing and Infill

3.1001.6c Sealant selection for firewall

- See Selection of All Sealants

3.1001.6d Joint seal at firewall

- Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections at:
  - The intersection between firewall and attic floor
  - If firewall assembly is not monolithic (e.g., balloon framing, CMU, open chase, attic bypass, or with similar penetration through the attic floor plane), attic floor plane penetrations within the firewall assembly will be accessed through the firewall, fully sealed, and firewall surface restored to prevent current or future breaches of the firewall below the attic floor plane from establishing an airflow path to the attic space

3.1001.7 Air Sealing of Firewall in Conditioned Attic

3.1001.7a Pre-inspection of firewalls in conditioned attic

- See Pre-inspection of firewall in unconditioned attics
- Air sealing locations will be identified between the firewall and the roof assembly, when sealing at the firewall is allowed by the local jurisdiction

3.1001.7b Backing and infill

- See Backing and Infill

3.1001.7c Sealant selection for firewall

- See Selection of All Sealants

3.1001.7d Joint seal

- Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections at:
  - The intersection between firewall and roof assembly
  - If firewall assembly is not monolithic (e.g., balloon framing, CMU, open chase, attic bypass, or with similar penetration through the attic floor plane), attic floor plane penetrations within the firewall assembly will be accessed through the firewall, fully sealed, and firewall surface restored to prevent current or future breaches of the firewall below the attic floor plane from establishing an airflow path to the attic space

3.1001.8 Preparing for and Installing Insulation Around High-Temperature Devices, Systems, and Components in the Attic

3.1001.8a Pre-inspection of heat-producing device (HPD)

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization
- Confirm that flues or other high-temperature elements are functioning as designed and do not present a fire or health and safety risk

3.1001.8b Verify attic preparation

- Confirm that only noncombustible sealant has been used in contact with chimneys, vents and flues, or any heat source (e.g., non-IC [insulation contact] rated recessed lights, heat lamps, etc.). Remove any noncompliant materials and replace them with materials consistent with application
- Sealant application at factory-built vents, flues, and chimneys shall be listed for use with that vent assembly
- Fire blocking in the space around site-built and factory-built chimneys, as required by either the IBC, IRC, or NFPA, as applicable, will be completed and inspected before construction of any insulation dams

3.1001.8c Isolation of HPD

- A rigid, fixed dam having a height greater than the insulation to be installed will be constructed to ensure a 3" clearance between combustion appliance vent and dam

3.1001.8d HPD sealant selection

- See Selection of All Sealants

3.1001.8e HPDs and Safety

- Insulation will not be allowed between a heat-generating appliance and a dam unless material is rated for contact with heat-generating sources

3.1001.8f Building operations staff education

- Documentation of material and R-value will be provided to building operations staff

3.1001.9 Sealing Access Doors and Similar Intentional Penetrations

3.1001.9a Worker safety and air sealing

- All worker safety specifications will be in accordance with Worker Safety Practices

3.1001.9b Occupant safety and air sealing

- Occupant will be notified of changes or repairs to be made
- An occupant safety plan will be prepared and implemented

3.1001.9c Air sealing pre-inspection for access doors, hatches, etc.

- If attic access is below the air and thermal boundary then the roof and any exterior roof access locations will be addressed
- The thermal boundary will be made airtight and insulated

3.1001.9d Sealant selection

- See Selection of All Sealants above

3.1001.9f Installation of attic doors, hatches, etc.

- Access hatches will be insulated with non-compressible insulation to the same R-value as adjoining insulated assembly
- Attic hatch rough opening will be surrounded with a durable, rigid protective baffle or layers of batt insulation that are higher than the level of the surrounding attic floor insulation

3.1001.9g Attachment

- Insulation will be permanently attached and in complete contact with the air barrier

3.1001.9h Quality assurance

- Attic access will be adjusted to properly fit the jamb and allow for ease of operation and security
- Attic access system will be tested for air leakage in accordance with ASTM E1186 standard

3.1001.9i Durability

- Completed measure will have a minimum expected service life of 20 years

3.1001.9j Building operations staff/occupant education

- Purpose of insulation and proper hatch operation will be communicated to building operations staff and occupant

3.1005 Other Ceiling Sealing Materials

3.1005.2 Skylights and Shafts

3.1005.2a Worker safety

- All worker safety specifications will be in accordance with Worker Safety Practices

3.1005.2b Occupant safety

- Occupants will be notified of changes or repairs to be made

3.1005.2c Pre-inspection of skylights and skylight shafts

- Glazing systems and curbs will be inspected for air and water leakage, integrity, proper operation, and security
- Repairs will be completed before insulation installation
- If the items above cannot be repaired, the glazing systems will be recommended for replacement before installing insulation
- Skylight shaft will be inspected to determine insulation strategy

3.1005.2d Sealant selection

- See Selection of All Sealants

3.1005.2e Sealing

- Holes and penetrations will be sealed
- Bypasses will be blocked and sealed
- Holes within fire-resistance-rated assemblies will be filled with a material permitted by the authority having jurisdiction and adopted building code

3.1005.2f Insulation installation

- Insulation will be installed in accordance with manufacturer specifications, and in full contact with all sides of existing cavity without gaps, voids, compressions, misalignments, or wind intrusions
- Fibrous insulation installed on the well walls will be adequately secured to prevent falling or shifting out of place, and will be installed with a continuous backing on the side exposed to the air
- Insulation will be installed to prescribed R-value
- Insulation will be installed to meet the specific characteristics of the assembly

3.1005.2g Building operations staff education

- Documentation of material and R-value will be provided to building operations staff

3.1005.3 Air Sealing Complex Ceiling Planes

3.1005.3a Pre-inspection

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization
- Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces
- Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating
- Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single ⅝" sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating
- Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins

3.1005.3b Locate air sealing plane

- Work area will be cleared of existing insulation to locate and identify the optimal air sealing plane

- Elevation changes, including interior soffits, chases, direct penetrations, and other changes in elevation, will be identified to determine which will be placed on the conditioned side of the air barrier and which will be sealed at all surfaces
- Where practical, the total square footage of the air barrier will be minimized by capping or sealing openings in the prime air-barrier plane, rather than on all sides of the elevation change

3.1005.3c Spanning material selection

- Materials used to span elevation changes will be rigid and self-supporting over the distance spanned
- Materials will be consistent with existing or intended fire-resistance assemblies
- Materials will be compatible with adjacent materials and with any proposed insulation designed to come in contact with it
- The perimeters of all materials installed to span elevation changes will be sealed on all exposed edges with compatible sealants
- Seals will be used that prevent visible air movement using chemical smoke at 50 pascals (Pa) of pressure difference

3.1005.3d Support Materials

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

3.1005.3e Joint seal

- A continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections
- Prefabricated units may be used when meeting the desired outcome

3.1005.3f Sealant selection

- See Selection of All Sealants

3.1005.3g Adjacent framing

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

3.1100 Air Sealing Walls

3.1101 Multi-Family Walls

Where not addressed by the Multi-Family Weatherization TRM, Section 32 Infiltration Reduction shall apply.

3.1102.1 Wall Penetration Sealing

3.1102.1a Pre-inspection

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization
- Gaps, cracks, and holes in fire separations located within the work area will be visually identified in the air barrier and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces
- Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating

- Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single ⅝" sheetrock, concrete masonry unit (CMU), and materials and methods employed will be consistent with restoring or preserving such inferred fire resistance rating
- Penetration locations will be identified to determine hole size and fire rating

3.1102.1b Backing and infill

- See Selection of All Sealants

3.1102.1c Wall sealant selection

- See Selection of All Sealants

3.1102.1d High-temperature applications

- Only noncombustible sealant will be used in contact with chimneys, vents and flues, or any heat source (e.g. non-IC [insulation contact] rated recessed lights, heat lamps, etc.)

3.1102.1e Penetration sealing

- Continuous seal will be installed around seams, cracks, joints, edges, and penetrations
- When a penetration goes all the way through a wall, both sides will be sealed
- In a hollow core CMU (concrete masonry unit or cinderblock) wall, the penetration at the inner wall surface and the exterior wall surface will be sealed, but not compromise existing water control measures (e.g., rain screen, drip edge, weep holes, gutter, and roof drains)

3.1200 Air Sealing at Windows & Doors

3.1201 Maintenance, Repair, and Sealing

3.1201.7 Air Sealing, Maintenance, and Weatherstripping at Windows

3.1201.7a Worker safety

- All worker safety specifications will be in accordance with Worker Safety Practices

3.1201.7b Occupant safety

- Occupant will be notified of changes or repairs to be made
- An occupant safety plan will be prepared and implemented
- Occupant will be shown how to properly operate the window system

3.1201.7c Pre-inspection of windows

- Glazing systems will be inspected for air and water leakage, warping, stability, holes, proper hardware operation, proper operation, and security; if the items above cannot be repaired, the glazing systems will be recommended for Energy Efficiency Upgrade

3.1201.7d Operable glazing system operation and fit

- Operable glazing system will be adjusted or repaired to properly fit the jamb and allow for ease of operation (e.g., hardware adjustment and/or replacement)

3.1201.7e Fixed glazing system adjustment and seal

- Fixed glazing system will be adjusted or repaired to properly fit the jamb

- In the event the fixed glazing unit has shifted enough to allow light to leak around the perimeter frame, the glass will be properly repositioned in its frame/pocket
- After repositioning/adjusting, the glass will be sealed to the frame
- When sealing exterior frame components, internal water drainage systems within the glazing system will be maintained
- When sealing exterior frame components, wall system water management components will be maintained (e.g., weep holes)

3.1201.7f Sealant selection

- See Selection of All Sealants

3.1201.7g Air sealing at window frame

- When the glazing system trim/frame leaks at wall, the glazing system trim/frame will be sealed to the exterior and/or interior side of the wall
- When the glazing system components leak at the frame, areas of leakage will be sealed
- When the existing window frame has penetrations due to old hardware, the abandoned penetrations will be sealed
- When sealing exterior frame components, internal water drainage systems within the glazing system will be maintained
- When sealing exterior frame components, wall system water management components will be maintained (e.g., weep holes)

3.1201.7h Window weatherstripping

- All weatherstripping will be an effective air barrier
- Durable weatherstripping material will be sized to span irregularities in the glazing system, as well as seasonal variations
- Where weatherstripping fits into an existing track, replacement weather strip will be sized to fit the original track and to span irregularities
- Weatherstripping will be installed and mechanically fastened around all four sides of the glazing system
- Mechanically installed weatherstripping carrier will be sealed to surface
- Operable glazing systems will be tested for ease of operation and airtightness after weatherstripping is installed

3.1201.7i Quality assurance for air sealing at windows

- Glazing system will be adjusted to properly fit the jamb and allow for ease of operation and security
- Glazing system will be tested for air leakage in accordance with ASTM E783-02 or ASTM E1186
- Water management systems and enclosure drainage planes will be verified as maintained

3.1201.8 Repair, Maintenance, and Weatherstripping of Doors

3.1201.8a Worker safety

- All worker safety specifications will be in accordance with Worker Safety Practices

3.1201.8b Occupant safety

- Affected occupants will be notified of changes or repairs to be made
- An occupant safety plan will be prepared and implemented

- Occupants will be notified of how to properly operate the door system

3.1201.8c Pre-inspection of door

- Door system will be inspected for air and water leakage, warping, stability, holes, proper hardware operation, proper operation, and security; if the items cannot be repaired, the door will be recommended for replacement as an Energy Efficiency Upgrade

3.1201.8d Door operation and fit

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

3.1201.8e Sealant selection

- See Selection of All Sealants

3.1201.8f Air sealing at door frame

- When the door trim/frame leaks at wall, the door trim/frame will be sealed to both the exterior and interior side of the wall
- Door stop will be sealed to door frame
- When the existing door frame has penetrations due to old hardware, the abandoned penetrations will be sealed
- Door rail (bottom) and threshold will be adjusted and sealed to ensure tight but operable fit

3.1201.8g Exterior door weatherstripping

- All weatherstripping will be an effective air barrier
- Durable weatherstripping material will be sized to span irregularities in the door/frame, as well as seasonal variations
- For sliders and commercial door systems where weatherstripping fits into an existing track, replacement weather strip will be sized to fit the original track and to span irregularities
- Weatherstripping will be installed around all four sides of the door
- Mechanically installed weatherstripping carrier will be sealed to surface
- Door will be tested for ease of operation and airtightness after weatherstripping is installed
- Where doors are required to have a fire-resistance rating, all weatherstripping and sealants applied to the door will be compatible with the listing of the door

3.1201.8h Quality assurance for air sealing at doors

- Door will be adjusted to properly fit the jamb, and allow for ease of operation and security
- Door system will be tested for air leakage in accordance with ASTM E783-02 or ASTM E1186 standards

3.1202 Repairing/Replacing Cracked and Broken Glass

See the Section 32 Infiltration Reduction for policies and installation criteria for this measure.

3.1203 Replacement of Windows and/or Doors

Replacement of windows or doors as an Energy Efficiency Upgrade must be cost-justified with a savings-to-investment ratio (SIR) of 1.0 as proven by energy audit. Windows and doors may not be replaced as air sealing measures in the CSD Weatherization Assistance Program.

3.1203.4 Window Replacement

3.1203.4a Design considerations

- When replacement is cost justified as an Energy Efficiency Upgrade:
  - Glazing type will be chosen by location in the building, building height, code, and climate
  - Window frame will be insulated and selected with thermal breaks appropriate to climate
  - Window selection will be based on lowest air leakage rating
  - Window selection will be based on National Fenestration Rating Council (NFRC) rating by climate
  - Glazing with lowest feasible U-value will be specified
  - Window glazing solar heat gain coefficient (SHGC) will be selected by building orientation and climate
  - Water management system will be maintained
  - Windows will meet the performance standard AMAA/WDMA/CSA (101/IS2/A440
  - Historic preservation requirements will be considered

3.1203.4b Window Pre-Inspection

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization

3.1203.4c Worker safety

- All worker safety specifications will be in accordance with Worker Safety Practices

3.1203.4d Occupant safety

- Occupants will be notified of changes or repairs to be made
- An occupant safety plan will be prepared and implemented
- Occupant will be shown how to properly operate windows and doors
- Building management and occupants will be notified about the risk of a child falling from operable windows with sills located more than 72" above any surface outside window opening

3.1203.4e Sealant selection

- See Selection of All Sealants

3.1203.4f Window location, installation, and sealing

- Glazing system frame will be aligned with the wall system's air and thermal boundary to create a continuous air and thermal boundary
- Glazing system will be installed in accordance with manufacturer specifications
- Rough opening will be prepared and sealed to the wall system's continuous air and thermal boundary with non-expanding sealants
- When replacement windows are being installed within an existing window frame where the original sash has been removed, the window frame will be prepared and sealed to the wall system's continuous air and thermal barrier
- When the existing window frame has internal weight pockets, the hardware will be removed and the pocket will be insulated and sealed
- Glazing system will be sealed to the airtight rough opening or the airtight existing frame

3.1203.4g Quality assurance for window replacements

- A sampling protocol will be used to test glazing system for air leakage in accordance with ASTM standard E783-02
- A sampling protocol will be used to test glazing system for water leakage in accordance with ASTM standard E1105-00

3.1203.5 Exterior Door Replacement

3.1203.5a Design considerations

- When replacement is cost justified as an Energy Efficiency Upgrade:
  - Door/glass will be selected by location in the building, building height, code, and climate
  - Door frame will be insulated and selected with thermal breaks appropriate to climate
  - Door selection will be based on lowest air leakage rating
  - Door selection will be based on National Fenestration Rating Council (NFRC) rating by climate
  - Door and door glazing with lowest feasible U-value will be specified
  - Glazing within door assemblies will comply with CPSC (Consumer Product Safety Commission) 16 CFR Part 1201
  - Door glazing SHGC (solar heat gain coefficient) will be selected by building orientation and climate
  - Water management system will be maintained
  - Historic preservation requirements will be considered

3.1203.5b Worker safety

- All worker safety specifications will be in accordance with Worker Safety Practices

3.1203.5c Occupant safety

- Affected occupants will be notified of changes or repairs to be made
- An occupant safety plan will be prepared and implemented
- Occupant will be shown how to properly operate the door system

3.1203.5d Sealant selection

- See Selection of All Sealants

3.1203.5e Door location, installation and sealing

- Door frame will be aligned with the wall system's air and thermal boundary to create a continuous air and thermal boundary
- Door system will be installed in accordance with manufacturer specifications
- Rough opening will be prepared and sealed to the wall system's continuous air and thermal boundary
- Door frame will be sealed and flashed to the airtight and watertight rough opening
- When a replacement door is being installed within an existing frame, the original frame will be prepared and sealed to the wall system's continuous air and thermal boundary, and the door will be weather stripped on all four sides
- When the existing door frame has penetrations due to old hardware, the abandoned penetrations will be sealed
- Door rail (bottom) and threshold will be adjusted to ensure tight but operable fit

3.1203.5f Quality assurance for door replacement

- Door will be adjusted to properly fit the jamb and allow for ease of operation and security
- A sampling protocol will be used to test door system for air leakage in accordance with the ASTM E783-02 or ASTM E1186 standards
- A sampling protocol will be used to test door system for water leakage in accordance with the ASTM E1105-00 standard

3.1300 Air Sealing Floors

See Section 32 Infiltration Reduction for policies and installation criteria for this measure.

3.1400 Air Sealing at Basements and Crawlspaces

See Section 32 Infiltration Reduction for policies and installation criteria for this measure.

3.1403 Slab Foundations

3.1403.1 Air Seal Concrete Floor Slab Foundation: Raised, On-Grade, and Below-Grade

3.1403.1a Pre-inspection

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization
- Where applicable (generally above-grade concrete slabs between conditioned and unconditioned spaces), gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces
- Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating
- Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single ⅝" sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating
- Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins

3.1403.1b Identification of penetrations

- Penetrations will be identified using visual inspections, smoke, and/or pressure tests as prescribed in the ASTM E1186-03 (2009) standard

3.1403.1c Preparation

- Health and safety concerns for occupants and workers, in relation to repairs and materials, will be addressed in accordance with CalOSHA Title 8, Subchapters 4, 7
- The area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos, carbon monoxide, moisture)
- Work lighting, work platform, and adequate ventilation will be provided
- Access not provided will be created to ensure that sealing repairs can be made

3.1403.1d Sealant and materials selection

- See Selection of All Sealants

- Where penetrations are due to failed or missing expansion joints, sealing materials will be suitable for this application

3.1403.1e Access construction repair

- Access holes will be repaired

3.1403.1f Verification

- Repairs will be verified by visual inspections, smoke, and/or pressure tests consistent with the pre-inspection

3.1488 Special Considerations for Air Sealing at Basements/Crawlspaces

3.1488.3 Covers for Sump Pumps, Drains, Pits, and Other Intentional Slab Penetrations

3.1488.3a Pre-inspection

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization
- Repairs necessary to stabilize treatment areas and protect or preserve integrity of energy improvement will be completed before subject work begins

3.1488.3c Building manager education

- Documentation of material requirements will be provided to property manager

3.1500 Attached Garages

See Section 32 Infiltration Reduction for policies and installation criteria for this measure.

3.1501 Garage Openings

3.1501.2 Garages—Sealing Penetrations

3.1501.2a Penetrations

- All lighting fixtures, wiring, plumbing, venting, ducting, and gas piping penetrations will be sealed

3.1501.2b Ductwork

- All ductwork in attached garage will be sealed in accordance with the duct sealing specifications
- Where duct system serves any other conditioned or living space, all supply and return openings (including intentional openings designed to heat or cool the garage space) must be disconnected, capped with sheet metal, and completely sealed

3.1501.2c Cracks

- All cracks in walls, ceilings, or floors that separate conditioned space from garage will be sealed, including cracks between mud sill, rim joists, subfloors, and bottom of gypsum board

3.1501.2d Door between garage and conditioned space

- Weatherstripping, door sweep, or threshold will be installed to stop air leakage in accordance with Repair, Maintenance, and Weatherstripping of Doors

- In accordance with California Residential Code (CRC), installed doors between garages and conditioned space must meet the following criteria:
  - Shall be a solid wood or steel door not less than 1⅜" in thickness or a 20-minute fire-rated door
  - Equipped with at least one self-closing hinge and a self-latching device

3.1501.2e Glass replacement in an exterior door

- Broken glass panes in doors will be replaced, pointed, and glazed, where needed
- Where glazing is permitted by code, verify that replacement glass meets the intended fire resistance of the assembly penetrated and is safety glazing as mandated by CPSC (Consumer Product Safety Commission) 16 CFR 1201
- Glazing located in wall connecting garage to conditioned space with fire-resistance ratings may be prohibited; confirm that existing glazing application is consistent with all applicable building codes

3.1501.2f Carbon monoxide (CO) alarm for homes with attached garages and/or have open combustion appliances in the garage

- Carbon monoxide alarms or detection systems that comply with applicable codes, laws, and ordinances will be tested and confirmed to be operational upon completion of any enclosure work

3.1501.2g Building operations staff/occupant education

- Occupant and building operations staff will be educated on need to keep door from garage to conditioned space closed and need to minimize the time any gas engine appliances or grilles are operated in the garage, even if the main door is left open

3.1502 Air Sealing and Isolation of Pollutant Source from Living Space

3.1502.1 Garages—Isolating from Living Spaces

3.1502.1a Pre-inspection of space, including combustion safety

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization
- Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces
- Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating
- Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single ⅝" sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating
- Pressure differential of all garages (both enclosed and open) to building will be measured
- Carbon monoxide (CO) levels will be measured in the garage and building under typical operating conditions before work begins
- Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins

3.1502.1b Identification of penetrations

- Penetrations will be identified using one or more of the following:
  - Visual inspections

  - Infrared thermography
  - Airflow detection smoke or visible mist
  - Induced pressure tests as defined in the ASTM E1186-03 (2009) standard
- The following will be areas included in the investigation:
  - Penetrations through walls and ceilings that separate garage from occupied space
  - Doorways between garage and occupied space
  - Cracks at sill and rim joist between garage and occupied space, basement, or crawlspace
  - Ductwork and heating, ventilation, and air conditioning equipment located in the garage that serves occupied space

3.1502.1c Preparation for Air Sealing

- Health and safety concerns for occupants and workers, in relation to repairs and materials will be addressed in accordance with CalOSHA Title 8, Subchapters 4, 7
- Carbon monoxide levels will be monitored in work areas during repair work consistent with relevant CalOSHA Title 8 requirements
- The area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos, carbon monoxide, etc.)
- Work lighting, work platform and adequate ventilation will be provided

3.1502.1d Selection of sealants

- See Selection of All Sealants

3.1502.1e Air sealing verification

- Pressure differential of garage to building will be measured
- Carbon monoxide levels in the building will be measured

3.1600 Ducts

Where not addressed by the Multi-Family Weatherization TRM, the Section 8 Ducting Repair, Sealing, and Insulation measure-specific policies apply.

3.1601 Duct Preparation

3.1601.6 Preparation and Mechanical Fastening—Low Rise Buildings

3.1601.6a Preparation of ducts

- Surrounding insulation will be cleared to expose the joints being sealed
- Duct surface that accepts sealant will be cleaned

3.1601.6b Metal to metal

- Rigid metal ducts will be fastened with a minimum of three equally spaced screws or acceptable mechanical connections

3.1601.6c Flex to metal

- Joints will be fastened with tie bands using a tie band tensioning tool or mechanical band, and sealed with approved mastic and UL 181B tape

3.1601.6d Duct board to duct board

- Joints will be fastened with a clinch stapler, rated tape, and mastic

3.1601.6e Duct board to flexible duct

- An appropriate take-off collar in accordance with NAIMA (North American Insulation Manufacturers Association) standards will be used and sealed with approved mastic

3.1601.6f Metal plenum to air handler cabinet

- Plenum will be fastened with a minimum of three equally spaced screws on each side
- Canvas connection between plenum and unit will be installed so that it does not reduce the inside dimensions of the duct

3.1601.6g Duct board plenum to air handler cabinet

- Termination bar or metal strip will be fastened with screws
- Duct board will be installed between the screw and the termination bar

3.1601.6h Terminal boot to wood

- Screws or nails will be used to fasten boot to wood
- Seams and boot to subfloor will be sealed with mastic

3.1601.6i Terminal boot to gypsum

- Boot hanger will be fastened to adjacent framing with screws or nails
- Boot will be connected to boot hanger with screws
- Integral snap boots will be installed
- Seams of boot will be sealed with mastic
- Boot to gypsum will be sealed with caulk in accordance with local code and standards

3.1601.6j Duct board to flexible duct

- An appropriate take-off collar in accordance with NAIMA (North American Insulation Manufacturers Association) standards will be used

3.1601.6k Replacement of duct insulation

- Insulation will be returned or replaced with equivalent R-value

3.1601.7 Duct Supports—Low Rise Buildings

3.1601.7a Support of duct types (applies to all duct types)

- Ductwork will be supported in accordance with the applicable code adopted by the jurisdiction
- Flexible duct board ducts and plenums will be supported by metal strapping rods or other materials in accordance with applicable standards (i.e., NAIMA North American Insulation Manufacturers Association)
- Support materials will be applied in a way that does not allow the ductwork to sag, crimp the ductwork, or cause the interior dimensions of the ductwork to be less than specified
- Metal ducts will be supported by metal strapping, rods, or other materials, per applicable standards

3.1601.8 Preparation and Mechanical Fastening—Mid and High Rise Buildings

3.1601.8a Preparation

- Surrounding insulation will be cleared to expose the joints being sealed

- Duct surface that accepts sealant will be cleaned

3.1601.8b Metal to metal

- Ducts will be fastened with a minimum of three equally spaced screws or acceptable mechanical connections

3.1601.8c Flex to metal

- Joints will be fastened with tie bands using a tie band tensioning tool or mechanical band, and sealed with approved mastic OR UL 181B tape

3.1601.8d Duct board to duct board

- In a repair or replacement, joints will be fastened with clinch stapler, rated tape, and mastic

3.1601.8e Duct board to flexible duct

- An approved take-off collar in accordance with NAIMA (North American Insulation Manufacturers Association, www.naima.org) standards will be used and sealed with approved mastic

3.1601.8f Phenolic board to phenolic board

- Joints will be a metal connection fastened together in accordance with manufacturer specifications

3.1601.8g Phenolic board to flexible duct

- Metal take-off collar will be used and mastic will be used on the outside in accordance with manufacturer specifications

3.1601.8h Phenolic board to air handler cabinet

- Plenum will be fastened with a minimum of three equally spaced screws on each side and sealed with mastic
- Canvas connection between plenum and unit will be installed so that it does not reduce the inside diameter of the duct

3.1601.8i Metal plenum to air handler cabinet

- Plenum will be fastened with a minimum of three equally spaced screws on each side and sealed with mastic
- Canvas connection between plenum and unit will be installed so that it does not reduce the inside dimensions of the duct

3.1601.8j Duct board plenum to air handler cabinet

- Termination bar or metal strip will be fastened with screws and sealed with mastic
- Duct board will be installed between the screw and the termination bar

3.1601.8k Terminal boot to wood

- Screws or nails will be used to fasten boot to wood
- Seams and boot to subfloor will be sealed with mastic

3.1601.8l Terminal boot to gypsum

- Boot hanger will be fastened to adjacent framing with screws or nails
- Boot will be connected to boot hanger with screws
- Integral snap boots will be installed
- Seams of the boot will be sealed with mastic

- Boot to gypsum will be sealed with caulk in accordance with local code and standards

3.1601.8m Replacement of duct insulation

- Insulation will be returned or replaced with current insulation standards

3.1601.9 Duct Supports—Mid and High Rise Buildings

3.1601.9a Support of duct types (applies to all duct types)

- Ductwork will be supported in accordance with applicable code adopted by the jurisdiction
- Flexible duct board ducts and plenums will be supported by metal strapping rods or other materials in accordance with applicable standards (i.e., NAIMA [North American Insulation Manufacturers Association])
- Support materials will be applied in a way that does not allow the ductwork to sag, crimp the ductwork, or cause the interior dimensions of the ductwork to be less than specified
- Metal ducts will be supported by metal strapping, rods, or other materials in accordance with applicable standards

3.1602 Duct Sealing

3.1602.14 Heating, Ventilation, and Air Conditioning Supply, and Return Ducts and Plenums

3.1602.14a Supply plenums (includes conditioned crawlspaces)

- Crawlspaces that are used as heating and cooling supply plenums will not be allowed

3.1602.14b Return plenums

- Crawlspaces that are used as heating and cooling return plenums will not be allowed

3.1602.14c Existing condition where crawlspace is used as supply and/or return plenum

- Condition will be corrected to provide supply and/or return plenums isolated from crawlspace before work can continue

3.1602.15 Ventilation Existing Duct Sealing (All Building Types)

3.1602.15a Pre-inspection of existing duct ventilation systems

- Specifications will be field verified as appropriate to site conditions by installer (e.g., fire dampers, other obstructions)
- Access to all elements of distribution system will be identified
- Access to all dwelling units and elements of distribution system will be ensured by the installer
- An inspection will be conducted for mold, water leaks, water damage, and breaches in the surfaces of the isolated space before sealing
- Repairs will be completed before subject work

3.1602.15b Duct health and safety

- Health and safety concerns for occupants and workers, in relation to repairs and materials, will be addressed in accordance with CalOSHA CalOSHA Title 8, Subchapters 4, 7

- Area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos)
- Work lighting, work platform, and adequate ventilation will be provided

3.1602.15c Identification of leakage locations

- Duct leakage sites will be identified using industry approved approaches (e.g., visual inspections, borescopes, remote cameras, infrared thermography, smoke, and/or pressure tests (i.e., ASTM E1186-03 (2009) standard)

3.1602.15d Identify and prioritize leakage locations to be sealed

- Duct sealing opportunities will be assessed and prioritized by:
  - Type of hole (in order of priority):
  - Catastrophic holes disconnected, missing ducts, or very large holes
  - Roof curb, close to fan, register boots
  - Holes larger than ¼"
  - Seams and joints (holes less than ¼")
  - Accessibility:
    - Easy to access
    - Demolition required
    - Access by internally applied sealants

3.1602.15e Temporary access

- When demolition for access is specified, the installer will:
  - Make the temporary access using appropriate containment and worker protection
  - Seal ductwork in accordance with manual sealing specifications listed in Duct sealing activities
  - Document repairs using photographs, checklist, and testing, as required
  - Repair the opening to specification

3.1602.15f Preparation of Ducts

- Ducts and registers will be cleaned before sealing
- Presence and type of dampers and smoke control devices will be identified and protected from duct-sealing application

3.1602.15g Material selection

- Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications
- Duct sealants will be UL 181 compliant
- Sealants and materials will be continuous and meet fire barrier specifications

3.1602.15h Duct sealing activities

- Manual sealing of all accessible leakage areas will be completed first:
  - Reconnect disconnected ducts
  - Repair missing ducts with like materials
- For holes greater than ¼", backer material with mastic or appropriate sealants will be used
- For holes smaller than ¼", mastic or appropriate sealants will be used. (Some sealed joints will allow for movement [e.g., steam pipes, deflection joints.])

- If specified, internally applied spray or aerosol sealing will only be applied after any manual sealing is complete
- Installer will coordinate access to the ventilation ductwork in the affected dwelling units with the building management and specialized subcontractor(s)
- Installer will provide logistical support to subcontractor(s) (e.g., remove/replace rooftop fans, mask duct terminations and openings, manually seal ducts, install flow orifices)
- Sealants and sprays will be applied in accordance with manufacturer specifications by a qualified contractor
- These final steps will be performed for all duct-sealing activities:
  - Ventilation system will be returned to operational conditions
  - Installer will document sealing was completed with photographs, checklist, and testing, as required
  - Installer will conduct final inspection and conduct close out meetings with building management

3.1602.15i Verification

- Final visual inspection of duct sealing activities and installer documentation will be completed
- Continued operation of dampers and smoke control devices will be verified
- Flows and pressures will be measured and balanced

3.1602.15j Combustion appliance zone testing

- Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards

3.1602.15k Occupant/building manager education

- Occupant/building manager will be educated on how the system works and its purpose
- Occupant/building manager will be instructed to not alter or make holes in the ventilation duct system

3.1602.16 Forced Air—Air Sealing System—Low Rise Building

3.1602.16a New duct component to new component sealant selection

- Any closure system used will meet or exceed applicable standards

3.1602.16b New duct component to existing component

- Seams, cracks, joints, holes, and penetrations less than ¼" will be sealed using fiberglass mesh and mastic
- Mastic alone will be acceptable for holes less than ¼" that are more than 10' from air handler
- Seams, cracks, joints, holes, and penetrations between ¼" and ¾" will be sealed in two stages:
  - They will be backed using temporary tape (e.g., duct tape) as a support prior to sealing
  - They will be sealed using fiberglass mesh and mastic

3.1602.16c Existing component to existing component

- Fiberglass mesh and mastic will overlap temporary tape by at least 1" on all sides
- Fiberglass mesh and mastic will become the primary seal

- Seams, cracks, joints, holes, and penetrations larger than ¾" will be repaired using rigid duct material

3.1602.17 Forced Air—Air Sealing System Components—Low Rise Building

3.1602.17a Duct boot to interior surface

- Gaps between boot and gypsum less than a ¼" will be sealed using mastic
- Gypsum edge will be wetted before applying mastic

3.1602.17b Wooden plenums and building cavities

- Accessible connections and joints will be made airtight using approved material

3.1602.17c Air handler cabinet

- Joints will be closed
- Cracks and holes not needed for proper function and service of unit will be sealed using removable (e.g., sealant such as UL 181 approved mastic tape

3.1602.17d Filter slot

- A pre-manufactured or site-manufactured durable and airtight filter slot cover will be installed

3.1602.18 Framed Platform—Low Rise Buildings

3.1602.18a Preparation

- Debris and dirt will be cleaned out of the return platform
- Ensure the platform will support the weight of the equipment

3.1602.18b Infill and backing

- Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the open space
- Backing or infill will not bend, sag, or move once installed
- Material will be rated for use in return duct systems

3.1602.18c Sealant selection

- Sealants will be compatible with their intended surfaces
- Sealants will be continuous and meet fire barrier specifications

3.1602.19 Dual Cooling Up-Ducts—Low Rise Buildings

3.1602.19a Backing and infill

- Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the up duct opening
- A material will be rated for use in duct systems
- The infill will not bend, sag, or move once installed

3.1602.19b Sealant selection

- Sealants will be compatible with their intended surfaces
- Sealants will be continuous and meet Class 1 specifications

3.1602.21 Air Sealing System—Mid and High Rise Buildings

3.1602.21a New duct component to new component sealant selection

- Any closure system used will meet or exceed applicable standards

3.1602.21b New duct component to existing component

- Seams, cracks, joints, holes, and penetrations less than ¼" will be sealed using fiberglass mesh and mastic
- Mastic alone will be acceptable for holes less than ¼" that are more than 10' from air handler
- Seams, cracks, joints, holes, and penetrations between ¼" and ¾" will be sealed in two stages:
  - They will be backed using temporary tape (e.g., duct tape) as a support before sealing
  - They will be sealed using fiberglass mesh and mastic

3.1602.21c Existing duct component to existing component

- Fiberglass mesh and mastic will overlap temporary tape by at least 1" on all sides
- Fiberglass mesh and mastic will become the primary seal
- Seams, cracks, joints, holes, and penetrations larger than ¾" will be repaired using rigid duct material

3.1602.22 Air Sealing System Components—Mid and High Rise Buildings

3.1602.22a Duct boot to interior surface

- Gaps between boot and gypsum less than a ¼" will be sealed using mastic
- Gypsum edge will be wetted before applying mastic

3.1602.22b Wooden plenums and building cavities

- Accessible connections and joints will be made airtight using approved material

3.1602.22c Air handler cabinet

- Joints will be closed
- Cracks and holes not needed for proper function and service of unit will be sealed using removable sealant (e.g., UL 181 approved mastic tape

3.1602.22d Filter slot

- A pre-manufactured or site-manufactured durable and airtight filter slot cover will be installed

3.1700 Building Additions

3.1701 Attached Additions

See Section 32 Infiltration Reduction for policies and installation criteria for this activity.

3.1800 Roofs

3.1801 Roof Decks, Panels, and Hatches

3.1801.1 Above Roof Deck Air Sealing and Insulation

3.1801.1a Worker safety

- Worker safety specifications will be in accordance with Worker Safety Practices

3.1801.1b Occupant safety

- An occupant safety plan will be prepared, reviewed with and approved by building operators, and implemented throughout production

3.1801.1c Pre-inspection of roof

- Existing roof water management system will be identified
- Existing roof system will be evaluated to determine suitable materials and techniques that will not compromise the integrity of the roofing system and will not adversely impact warranty or serviceability of roofing system after work has been performed
- Nail base strategy for the perimeter of the roof will be determined to guide how the flashing and/or roof will be anchored at the exterior of the building

3.1801.1d Roof covering removal

- Existing roof covering will be removed

3.1801.1e Sealing of roof deck

- If the existing roof deck can be used as an air barrier, joints, seams, holes, gaps, and penetrations will be sealed with sealants compatible with existing materials, and as approved by both sealant manufacturer and manufacturer of materials being sealed

3.1801.1f Installation of insulation

- Insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or exposure to wind intrusion or UV (ultraviolet) rays
- Insulation will be installed to prescribed R-value
- Before rigid insulation installation is installed, a bead of sealant will be laid along the perimeter of the roof deck to prevent air infiltration and again at subsequent layers of insulation board
- Roof and wall water management systems will be maintained or installed (when needed and it is a cost-effective incidental repair)

3.1801.1g Roof covering replacement

- New roof covering will be installed in accordance with manufacturer specifications and local building code requirements

3.1801.1h Building operations staff education

- Documentation of material and R-value will be provided to building operations staff

3.1802 Roof/Wall Connections

See Section 32 Infiltration Reduction for policies and installation criteria for this activity.

3.1900 Compartmentalization

3.1901 Multi-Family Compartmentalization Techniques

3.1901.1 General Compartmentalization Techniques

3.1901.1a Pre-inspection of dwelling units and adjacent areas

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization
- Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces
- Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating
- Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single ⅝" sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating
- Repairs necessary to stabilize work areas, and protect or preserve integrity of energy improvement will be completed before subject work begins

3.1901.1b Identification of penetrations

- Penetrations will be identified using visual inspections, infrared thermography, smoke, and/or pressure tests as prescribed in the ASTM E1186-03 (2009) standard

3.1901.1c Preparation of work area

- Health and safety concerns will be addressed for occupants and workers, in relation to repairs and materials, will be addressed in accordance with CalOSHA Title 8, Subchapters 4, 7
- The area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos)
- Work lighting, work platform, and adequate ventilation will be provided

3.1901.1d Sealant and materials selection

- See Selection of All Sealants

3.1901.1e Verification

- Repairs will be verified by visual inspections, infrared thermography, smoke, and/or pressure tests consistent with the pre-inspection

3.1901.2 Performance-Based Air Sealing of Dwelling Units and Corridors

3.1901.2a Pre-inspection of dwelling units and corridors

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization
- Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces
- Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating

- Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single ⅝" sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating
- Work order repairs requiring access to dwelling units will be reviewed with all relevant authorities (e.g., building management, property management)
- Access to work areas within dwelling units will be obtained
- Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins

3.1901.2b Work coordination among trades

- Work will be coordinated with all other trades performing work in compartmentalized spaces to schedule any required system wide test-out verification

3.1901.2c Preparation of work area

- Health and safety concerns for occupants and workers, in relation to repairs and materials, will be addressed in accordance with CalOSHA Title 8, Subchapters 4, 7
- The area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos)
- Work lighting, work platform, and adequate ventilation will be provided

3.1901.2d Identification of penetrations

- Penetrations will be identified using visual inspections, infrared thermography, smoke, and/or pressure tests as prescribed by the ASTM E1186-03 (2009) standard
  - Work must preserve existing ventilation performance, including apartment door undercuts, where existing central ventilation design incorporates these undercuts as an intentional pathway from hallways to apartments

3.1901.2e Installation, sealant, and materials selection

- See Selection of All Sealants

3.1901.2f Verification

- Repairs will be verified by pressure tests consistent with the pre-inspection
- Any pressure balance test-out verification will be performed after all work from all trades is completed

3.1901.2g Property manager/occupant education

- Documentation of material and maintenance requirements will be provided to property manager/occupant, as appropriate

4. INSULATION

The Multi-Family Weatherization TRM policies pertaining to installation of insulations shall be applicable. If certain installation practices are not addressed in this section, the Section 37 Attic and Ceiling Insulation, Section 39 Floor Insulation, or Section 38 Wall Insulation policies will be applied.

2.0703.1 Sealing/Isolating Exposed Fibrous Insulation in Areas with Routine Human Activity

2.0703.1a Fibrous insulation isolation

- Fibrous insulation materials will be encapsulated on all surfaces facing spaces where there is routine human activity
- Encapsulation materials will be fire rated, if applicable, to preserve the pre-retrofit fire rating of the building assembly, and/or as required by insulation manufacturer or relevant building code
- Vapor permeability of encapsulation materials will be consistent with predetermined vapor retarder placement

4.1000 Attics

4.1001 General Preparation

See Section 37 Attic and Ceiling Insulation for policies and installation criteria for this activity.

4.1003 Attic Ceilings

Unless addressed below, see Section 37 Attic and Ceiling Insulation for policies and installation criteria for this activity.

4.1003.14 Accessible Unvented Flat Roof with or without Existing Insulation

4.1003.14a Worker safety

- All worker safety specifications will be in accordance with Worker Safety Practices

4.1003.14b Occupant safety

- An occupant safety plan will be prepared and implemented

4.1003.14c Pre-inspection of area to be insulated

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization
- Insulation will not be installed if moisture-related issues are not resolved

4.1003.14d Preparation for insulation

- New insulation that is not designed to also serve as an air barrier will not be added until all air sealing has been completed at the air and thermal boundary
- Existing insulation will be inspected to confirm that it is not concealing air barrier and is in full contact and alignment with the air barrier
- Where the insulation is disturbed or found not to be in contact with the air barrier, it will be reinstalled to be in contact with the air barrier. If it cannot be reinstalled or if its condition compromises its effectiveness, the insulation will be removed
- Insulation will be marked for depth a minimum of every 300 square feet of attic area with measurement beginning at the air barrier
- All electrical junctions will be flagged to be seen above the level of the insulation
- Covers will be installed on open electrical junction boxes

- Insulation dams and enclosures for HPDs (e.g., can lights, sprinkler systems, access hatch, chimney) will be installed as required
- Where loose fill or batt insulation is used, it will have a maximum 25 flame spread/50 smoke-developed index when tested to ASTM E84 or UL 723 standards
- Where rigid foam plastics are used, in no case will the final thickness exceed the manufacturer's tested thickness (used to determine the maximum 75 flame spread and 450 smoke-developed index when tested to ASTM E84 or 723 standards)
- Foam will be provided with ignition and thermal boundaries as required by code

4.1003.14e Installation

- Attic insulation will be installed without gaps, voids, compressions, misalignments, or wind intrusions
- Roof cavities will be blown with loose-fill insulation without gaps, voids, compressions, misalignments, or wind intrusions
- Insulation will be installed to prescribed R-value
- Final R-value will account for the compression of existing insulation

4.1003.14f Ventilation

- Code compliant ventilation will be installed before insulation

4.1003.14g Occupant education

- A dated receipt signed by the installer will be provided that includes:
  - Insulation type
  - Coverage area
  - R-value
  - Installed thickness and minimum settled thickness
  - Number of bags installed in accordance with manufacturer specifications

4.1004 Attic Knee Walls

See Section 37 Attic and Ceiling Insulation for policies and installation criteria for this activity.

4.1005 Attic Floors

4.1005.8 Loose Fill Over Existing Insulation on Accessible Attic Floors

4.1005.8a Preparation of attic floor

- New insulation will not be added until all air sealing has been completed
- Existing insulation will be inspected to confirm that it is not concealing air barrier weaknesses and is in full contact and alignment with the air barrier
- Where the insulation is disturbed or found not to be in contact with the air barrier, it will be reinstalled to be in contact with the air barrier. If it cannot be reinstalled or if its condition compromises its effectiveness, the insulation will be removed
- Insulation will be adequately marked for depth a minimum of every 300 square feet of attic area with measurement beginning at the air barrier
- All electrical junctions will be flagged to be seen above the level of the insulation
- Open electrical junction boxes will have covers installed
- Insulation dams and enclosures will be installed as required
- Blocking will be installed to maintain existing vented attic functionality

4.1005.8b Installation of insulation

- The correct depth and number of bags will be blown in accordance with manufacturer specifications
- Insulation will be installed to prescribed R-value
- Final R-value will account for the compression of existing insulation

4.1005.8c Safety

- Insulation will not be allowed on top of non-insulation contact (non-IC rated can light) boxes or between a heat-generating appliance and a dam unless material is rated for contact with heat-generating sources)
- All insulation materials used will meet ASTM standard E84 flame spread/smoke development rating of 25/50

4.1005.8d Onsite documentation

- A dated receipt signed by the installer will be provided that includes:
  - Insulation type
  - Coverage area
  - R-value
  - Installed thickness and minimum settled thickness
  - Number of bags installed in accordance with manufacturer specifications

4.1006 Attic Openings

See Section 37 Attic and Ceiling Insulation for policies and installation criteria for this activity.

4.1088 Special Considerations

4.1088.7 Insulating Inaccessible Attics

4.1088.7a Worker safety

- All worker safety specifications will be in accordance with Worker Safety Practices

4.1088.7b Pre-inspection

- Attics that cannot be air sealed will not be filled with blown insulation
- At no time will dense pack insulation products be considered an appropriate air barrier material for an inaccessible attic
- Where attic spaces are inaccessible for air sealing, top of building thermal boundary may be insulated using methods and techniques outlined in Above Roof Deck Air Sealing

4.1088.8 Installation/Correction of Unconditioned Attic Ventilation

4.1088.8a Pre-inspection

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization

4.1088.8b Air barrier and thermal boundary

- Attic ventilation will be recommended or installed only if:
  - The presence of an effective air barrier and thermal boundary between the attic and the living space is verified
  - Appropriate attic sealing and proper insulation is specified as part of the work scope

- Ignition barrier and thermal boundaries are provided when foam plastic materials are used

4.1088.8c Vent type

- Attic vent types will be consistent with requirements for their specific location (e.g., exterior soffit, gable end, roof) and material and intended use (e.g., metal vent on metal roof)
- Ventilation opening area and configuration will comply with applicable building code

4.1088.8d Vent location

- Placement of attic vents will be considered for proper airflow and prevention of entry of wind-driven rain or snow

4.1088.8e Ventilation baffling

- Baffling for attic soffit vents will be installed to:
  - Ensure proper airflow
  - Prevent wind washing of insulation
  - Allow maximum insulation coverage
  - Ensure baffle terminates above insulation
- Minimum clearance between insulation and roof deck will be 1"

4.1088.8f Ventilation screens

- All attic ventilation will have screens with noncorroding wire mesh with openings of ⅛" to prevent pest entry (e.g., birds, bats, bees)
- Existing vents that are not screened will be covered with noncorroding wire mesh with openings of ⅛"

4.1088.9 Tenting, Air Sealing, and Insulating Wet Sprinkler System Components in Unconditioned Attic Spaces

4.1088.9a Worker safety

- All worker safety specifications will be in accordance with Worker Safety Practices

4.1088.9b Occupant safety

- An occupant safety plan will be prepared and implemented

4.1088.9c Pre-inspection

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization
- Ensure a durable, continuous air barrier and thermal boundary are present
- Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces
- Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating
- Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single ⅝" sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating
- Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins

- Insulation will not be installed if moisture-related issues are not resolved

4.1088.9d Sealant selection

- See Selection of All Sealants

4.1088.9e Installation

- When tenting is required, an airtight, rigid, and insulated enclosure will be installed around entire sprinkler system exposed within the attic
- Enclosure will be sealed to the existing attic air barrier
- Fire-rated materials will be used when applicable
- Insulation will be installed on top of enclosure to the same R-value as the rest of the attic or rigid insulated enclosure will have an equivalent R-value as the rest of the attic

4.1100 Wall Insulation

4.1101Preparation

See Section 38 Wall Insulation for policies and installation criteria for this activity.

4.1102Accessible Walls

See Section 38 Wall Insulation for policies and installation criteria for this activity.

4.1103Enclosed Walls

4.1103.4 Dense Packing Blown Insulation

4.1103.4a Worker safety

- All worker safety specifications will be in accordance with Global Worker Safety
- Lead safety procedures in buildings built before 1978 will be followed, unless approved testing method proves absence of lead based paint in surfaces that will be disturbed

4.1103.4b Occupant safety

- Occupant will be notified of changes or repairs to be made
- An occupant safety plan will be prepared and implemented

4.1103.4c Pre-inspection

- Conduct pre-inspection in accordance with Worker Safety Practices
- Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces
- Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating
- Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single ⅝" sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating
- Repairs necessary to stabilize work areas and protect or preserve the integrity of energy improvement will be completed before work begins

- Insulation will not be installed if moisture-related issues are not resolved
- Existing water control measures will be identified
- Air sealing locations on the exterior walls will be identified
- Air sealing will be completed before installing insulation

4.1103.4d Wall access

- When feasible, insulation will be installed into cavities from the exterior side of the wall
- When feasible, exterior cladding at the insulation access point will be removed before creating an access hole through the sheathing
- Insulation access point will be created to minimize and drainage plane disruption
- Access point will be sealed to be airtight and watertight after insulation installation before reinstalling the exterior cladding
- Water management system will be repaired to function as originally intended (e.g., lapping new felt paper underneath the upper and over the lower joint of the existing felt paper)

4.1103.4e Sealant selection

- See Selection of All Sealants

4.1103.4f Exterior dense pack

- Using fill tube, 100% of each cavity will be completely filled to a consistent density:
  - Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater density
  - Blown fiberglass, mineral fiber, rock and slag wool, or spray foam used in an enclosed cavity will be installed in accordance at or above manufacturer recommended density to limit airflow that corresponds to an air permeance value of 3.5 cubic feet per minute/square feet at 50 Pa, as measured using the these applicable methods in ASTM C 522, or ASTM E 283, or ASTM E 2178
  - All insulation materials used will meet ASTM E84 flame spread/smoke development rating of 25/50
  - The number of bags installed will be confirmed and will match the number required on the coverage chart
- Insulation will be verified to prevent visible air movement at 50 Pa of pressure difference using chemical smoke or other approved verification method by the authority having jurisdiction

4.1103.4g Onsite documentation

- A dated receipt signed by the installer will be provided that includes:
  - Coverage area
  - Thickness
  - R-value

4.1103.5 Exterior Wall Surface Insulation

4.1103.5a Worker safety

- All worker safety specifications will be in accordance with Worker Safety Practices

4.1103.5b Occupant safety

- Occupant will be notified of changes or repairs to be made
- An occupant safety plan will be prepared and implemented

4.1103.5c Pre-inspection of exterior wall surface

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization
- Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before exterior wall is insulated
- Insulation will not be installed if moisture-related issues are not resolved
- Existing water control measures will be identified
- Air sealing locations will be identified on the exterior walls
- Air sealing will be completed before installing insulation unless an alternative system will be applied
- For structures covered by the International Building Code (IBC) standard IBC 2603.4, all exterior walls to be insulated will be assessed for provision of a thermal boundary (fire stopping) when foam insulating materials are to be used

4.1103.5d Prepare substrate

- Exterior siding will be removed as appropriate
- Where siding materials contain lead, lead-safe work practices will be used
- Where siding contains asbestos, relevant codes regarding its removal and reinstallation will be determined and followed
- Insulation will not be installed until mold, water leaks, water damage, and pest issues are resolved
- Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins

4.1103.5e Sealant selection

- See Selection of All Sealants

4.1103.5f Installation of wall insulation

- Insulation will be installed to provide a continuous thermal (insulation) barrier to achieve the specified R-value for the assembly being insulated
- Where the insulation material does not provide an air barrier as installed, air sealing is required to create a continuous air barrier in direct contact with thermal (insulation) barrier
- Water management system will be continuous to protect the building
- Air and thermal boundaries will be integrated with other building systems

4.1103.5g Onsite documentation

- A dated receipt signed by the installer will be provided that includes:
  - Insulation type
  - Coverage area
  - R-value
  - Installed thickness and settled thickness (settled thickness required for loose-fill only)
  - Number of bags installed in accordance with manufacturer specifications (for loose-fill only)

4.1300 Floors

4.1301 Accessible Floors

4.1301.10 Above-Grade Exposed Floor, Joisted Assemblies

4.1301.10a Pre-inspection of floor

- Conduct pre-inspection in accordance with Work Area Inspection and Stabilization
- Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces
- Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating
- Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single ⅝" sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating
- Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins

4.1301.10b Preparation to insulate

- Health and safety concerns will be addressed for occupants, workers, and repair materials in accordance with CalOSHA Title 8, Subchapters 4, 7
- Prepare and isolate the area in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos, carbon monoxide)
- Work lighting, work platform, and adequate ventilation will be provided

4.1301.10c Subfloor preparation

- Sealing between conditioned space and unconditioned space will be completed before insulating

4.1301.10d Installation of floor insulation

- Insulation will be installed to at least prescribed R-value
- Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions
- If vapor retarders are used, they will be installed consistent with local climate/code requirements

4.1301.10e Installation of batts or dense pack

- Insulation will completely fill the cavity space within the joists or trusses
- Insulation will be installed either as in-fill or at the bottom of the joists
- Where insulation is installed between joists, the perimeter of each joist bay will be air sealed with appropriate sealants to prevent air bypasses around insulation materials
- A continuous air barrier will be installed below the insulation and to the exterior
- Insulation will completely fill the cavity space within the joists or trusses
- Batts will be secured with physical fasteners

4.1301.10f Installation of rigid insulation

- Rigid insulation will be mechanically fastened to the bottom of the subfloor or at the bottom of the joists or trusses
- If attached at the bottom of the joists or trusses, rigid insulation will be attached at the exterior perimeter/band
- Insulation will be installed either as in-fill or at the bottom of the joists. Where rigid insulation is installed between joists, the perimeter of each joist bay will be air sealed with appropriate sealants to prevent air bypasses around rigid insulation materials
- Rigid foam plastics used as insulation will incorporate a thermal and ignition barrier, as required by the building code
- A continuous air barrier will be installed below the insulation and to the exterior

4.130.10g Installation of spray polyurethane foam (SPF)

- If allowed by CSD, SPF will be applied to bottom side of subfloor between floor joists and all rim/band joists
- SPF insulation products incorporate a thermal and ignition barrier as required by building code
- SPF insulation will only be installed by trained foam installers

4.1301.10h Installation, if mechanicals in joisted assemblies (applies to all insulation types)

- All plumbing or mechanical ductwork will be enclosed within the insulated space and will have sufficient insulation on the exterior side

4.1301.10i Secure batts

- Batts will be secured with physical fasteners

4.1301.10j Rigid protective barrier

- A continuous rigid barrier, suitable to withstand weather, moisture, and pest contact, and with a fire-resistance rating equal to the resistance rating of the original floor assembly will be mechanically fastened to underside of floor assembly

4.1301.10k Property manager education

- A dated receipt signed by the installer will be provided that includes:
  - Insulation type
  - Coverage area
  - R-value
  - Installed thickness and settled thickness (settled thickness required for loose-fill only)
  - Number of bags installed in accordance with manufacturer specifications (for loose-fill only)

4.1301.11 Pier Construction Subfloor Insulation—Batt Installation with Rigid Barrier

4.1301.11a Subfloor preparation

- Sealing between conditioned space and crawlspace will be completed before insulating work begins

4.1301.11b Installation

- Insulation will be cut as necessary to fit between the floor joists and installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions

- If kraft-faced batts are used, they will be installed with kraft facing to subfloor
- Insulation will be installed to prescribed R-value

4.1301.11c Secure batts

- Batts will be secured with physical fasteners

4.1301.11d Rigid air barrier

- A rigid air barrier will be mechanically fastened to underside of floor assembly
- Seams and penetrations will be sealed
- Rigid barrier will be resistant to pests
- At minimum, all gaps larger than ¼" x ¼" will be stuffed with copper metal mesh or other rodent-proof material
- If rodents can easily get their mouth around corners, they will be reinforced with hardware cloth or metal angle (e.g., gypsum board bead)

4.1301.11e Building operations staff education

- A dated receipt signed by the installer will be provided that includes:
  - Coverage area
  - Thickness
  - R-value

4.1400 Basements and Crawlspaces

Where not addressed by the Multi-Family Weatherization TRM, Section 39 Floor Insulation shall apply.

4.1600 Duct Insulation

4.1601 Insulating Ducts

4.1601.6 Insulating Metal Ducts—Low Rise Buildings

4.1601.6a Selection of duct insulation material

- Duct insulation will be a minimum of R-8, in accordance with local code, or buried under attic insulation, whichever is greater, and have an attached vapor barrier

4.1601.6b Duct sealing

- Before insulation is applied, all accessible ducts will be sealed with a UL-approved mastic in conformance with the applicable code adopted by the jurisdiction

4.1601.6c Attachment of duct insulation

- Duct insulation will be secured to the duct system using an appropriate material per applicable standards that will securely hold the insulation to the ductwork, without compressing the insulation in the process

4.1601.6d Sealing of the duct insulation

- Using a tape or mastic approved by the manufacturer, all seams and connection of the duct insulation will be sealed
- No gaps will exist between pieces of duct insulation

4.1601.7 Insulating Metal Ducts—Mid and High Rise Buildings

4.1601.7a Selection of duct insulation material

- Duct insulation will be a minimum of R-8, in accordance with local code, or buried under attic insulation, whichever is greater, and have an attached vapor barrier
- Vapor barrier A material that retards the passage of water vapor and contains a perm rating of less than 1

4.1601.7b Duct sealing

- Before insulation is applied, all accessible ducts will be sealed with a UL-approved mastic in conformance with the applicable code adopted by the jurisdiction

4.1601.7c Attachment of duct insulation

- Duct insulation will be secured to the duct system using an appropriate material per applicable standards that will securely hold the insulation to the ductwork, without compressing the insulation in the process

4.1601.7d Sealing of the duct insulation

- Using a tape or mastic approved by the manufacturer, all seams and connections of the duct insulation will be sealed
- No gaps will exist between pieces of duct insulation

4.9900 Insulation—Additional Resources

See Section 8 Ducting Repair, Sealing, and Insulation for duct insulation criteria.

5. HEATING AND COOLING

Where specific heating or cooling repair/replacements are not addressed in this section, the Section 4 Heating and Cooling policies and measure-specific policies shall apply.

5.3000 Forced Air Systems

5.3001 Design

5.3001.4 Equipment Selection—Low Rise Building

5.3001.4a Load calculation: heat loss or gain

- Heat loss or gain of the building will be calculated considering the following:
  - R-values of building components
  - U-value and solar heat gain coefficient of glazing
  - Orientation and exterior shading of glazing
  - Duct heat loss or gain
  - Infiltration target or final infiltration after air sealing is completed
  - Ventilation
  - Internal gains
- ANSI/ACCA Manual J Residential Load Calculation, 8th ed., and ANSI/ACCA 5QI HVAC Quality Installation Specification requirements or ASHRAE equivalents will be used for all residential load calculations
- ANSI/ACCA Manual N Commercial Load Calculation or ASHRAE equivalents will be used for all commercial load calculations
- Room-by-room calculations will be performed when installing new duct systems or in retro-commission projects

5.3001.4b Load calculation: design conditions of single stage or single speed equipment

- Interior design temperatures will be selected based on 75° for cooling and 70° for heating, unless otherwise stated by local code
- Ensure the design loads reflect peak sensible and peak latent load conditions per ASHRAE Handbook—Fundamentals
- Design sensible loads, which will dominate in dry climates, should be based upon outdoor design cooling conditions for the location (e.g., peak cooling dry bulb temperature in the ASHRAE Handbook—Fundamentals)
- Design latent loads, which are most important in moist or humid climates, should be based upon design dehumidification conditions for the location (e.g., design dew point temperature and mean coincident dry bulb temperature in the ASHRAE Handbook—Fundamentals)

5.3001.4c Load calculation: design conditions for multistage, variable speed equipment

- Interior design temperatures will be selected based on 75° for cooling and 70° for heating, unless otherwise stated by local code
- Ensure the design loads reflect peak sensible and peak latent load conditions per ASHRAE Handbook—Fundamentals
- Design sensible loads, which will dominate in dry climates, should be based upon outdoor design cooling conditions for the location (e.g., peak cooling dry bulb temperature in the ASHRAE Handbook—Fundamentals)

- Design latent loads, which are most important in moist or humid climates, should be based upon design dehumidification conditions for the location (e.g., design dew point temperature and mean coincident dry bulb temperature in the ASHRAE Handbook—Fundamentals)

5.3001.4d Equipment selection: air conditioning and heat pumps

- Equipment capable of meeting the sensible and latent load of the building will be selected using the detailed capacity tables provided by the manufacturer
- Equipment will not be sized by more than 115% of total load or next available size
- ANSI/ACCA Manual S Residential Equipment Selection, and ANSI/ACCA 5 QI HVAC Quality Installation Specification requirements or ASHRAE equivalents will be used for all residential equipment selection
- ANSI/ACCA Manual CS Commercial Applications Systems and Equipment or ASHRAE equivalents will be used for all commercial equipment selection

5.3001.4e Equipment selection: auxiliary heat for heat pumps

- Use the lowest capacity heating equipment required to heat the building, utilizing the detailed capacity tables provided by the equipment manufacturer
- Equipment will be selected to provide a changeover point, calculated using information from the detailed capacity tables provided by the equipment manufacturer, weather data, and utility cost

5.3001.4f Equipment selection: furnaces

- The smallest capacity heating equipment will be selected that is capable of meeting the design heating load and providing the air movement required by the air conditioning
- When an air-conditioning system is not designed with the furnace, the smallest capacity heating equipment will be selected that is capable of meeting the heating load
- The lowest capacity cooling equipment required to cool the building will be used
- Equipment will not be sized by more than 115% of total load or next available size

5.3001.5 Ductwork and Termination Design—Low Rise Building

5.3001.5a Sizing

- Ducts will be sized to deliver the appropriate amount of airflow (both supply and return) needed to satisfy the heating and/or cooling load of the building
- Ducts will be sized using friction charts
- ANSI/ACCA Manual D Residential Duct Systems or ASHRAE equivalents will be used for all residential ductwork sizing
- ANSI/ACCA Manual Q Low Pressure, Low Velocity Duct System Design or ASHRAE equivalents will be used for all commercial ductwork sizing

5.3001.5b Air handler to return plenum

- Return plenum will be designed in accordance with ANSI/ACCA Manual D or equivalent
- Radius elbow fittings or square fittings with turning vanes will be used to direct return air when a 90° turn is required
- Supply plenum will be designed in accordance with ANSI/ACCA Manual D or equivalent
- Radius elbow fittings or square fittings with turning vanes will be installed to direct supply air

- Supply plenum will be the same size as the air handler supply opening

5.3001.5c Air handler to supply plenum

- Supply plenum will be designed in accordance with ANSI/ACCA Manual D or equivalent
- Radius elbow fittings or square fittings with turning vanes will be installed to direct supply air
- Supply plenum will be the same size as the air handler supply opening

5.3001.5d Building cavities used as ductwork

- Building cavities will not be used as ductwork in new systems
- In existing systems, building cavities will be sealed and tested

5.3001.5e Reducers

- Reducers between sections of different size ducts will be in accordance with existing standards based on duct material (SMACNA, NAIMA)

5.3001.5f Supply branch run outs

- Runs will be installed as short as possible

5.3001.5g Boots

- If using flexible duct with straight boots, duct will be connected to boot with no bend
- A rigid elbow will be used when a flexible duct changes direction
- A rigid connector will be used when joining two pieces of flexible duct together

5.3001.5h Supply terminations

- Terminations will be selected based on ACCA Manual T Air Distribution Basics

5.3001.5i Return grille sizing

- Terminations will be selected based on ACCA Manual T Air Distribution Basics
- Grille gross area will be equal to or larger than return box

5.3001.5j Manual volume dampers

- Dampers will be installed as close to the trunk as possible while still being accessible to allow for adjustment after interior finishes are installed

5.3001.5k Flexible ducts

- Flexible ducts will not be bent more than 45° without rigid elbow

5.3001.5l Take-offs

- Take-offs that create high turbulence will not be used (e.g., elbows with integrated dampers, scoops)
- Take-offs will be installed onto the trunk in accordance with duct construction standards (SMACNA)

5.3001.5m Fire dampers

- Fire dampers shall be installed as required by applicable fire code

5.3001.6 Load Calculation and Equipment Selection—Mid and High Rise Building

5.3001.6a Load calculation: heat loss or gain

- Heat loss or gain of the building will be calculated considering the following:
  - R-values of building components
  - U-value and solar heat gain coefficient of glazing
  - Orientation and exterior shading of glazing
  - Duct heat loss or gain
  - Infiltration target or final infiltration after air sealing is completed
  - Ventilation
  - Internal gains
- ANSI/ACCA Manual J Residential Load Calculation, 8th ed. and ANSI/ACCA 5 QI HVAC Quality Installation Specification requirements or ASHRAE equivalents will be used for all residential load calculations
- ANSI/ACCA Manual N Commercial Load Calculation or ASHRAE equivalents will be used for all commercial load calculations
- Room-by-room calculations will be performed when installing new duct systems or in retro-commission projects

5.3001.6b Equipment selection

- ANSI/ACCA Manual S Residential Equipment Selection and ANSI/ACCA 5 QI HVAC Quality Installation Specification requirements or ASHRAE equivalents will be used for all residential equipment selection

5.3001.6c Variable refrigerant flow selection

- When applicable, multiple indoor units will be supplied by a single outdoor unit
- When applicable, manufacturer specifications will be used to determine allowable overage of indoor unit capacity in relation to the outdoor unit
- When applicable, units will be selected that offer ducting options (e.g., ceiling cassette units have a knock-out for a 5" or 6" duct)
- When applicable, units with an outdoor air intake will be selected
- When design temperature is less than temperatures in the capacity tables, units will be de-rated in accordance with manufacturer specifications

5.3001.6d Ductless mini split selection

- When applicable, multiple indoor units will be supplied by a single outdoor unit
- When applicable, manufacturer specifications will be used to determine allowable overage of indoor unit capacity in relation to the outdoor unit
- When applicable, units will be selected that offer ducting options (e.g., ceiling cassette units have a knock-out for a 5" or 6" duct)
- When applicable, units with an outdoor air intake will be selected

5.3001.6e Package terminal air conditioner (PTAC) or package terminal heat pump selection

- Package unit will be selected with outdoor air intake unless other ventilation strategy is present
- Primary heating of newly installed PTAC units will not be electric resistance heat

5.3001.6g Economizer selection

- The need for an economizer outdoor air damper will be determined in accordance with the ASHRAE 90.1 minimum requirements or local code

5.3002 Site Preparation

5.3002.2 Sequence of Operation—Low Rise Building

5.3002.2a Verification

- The sequence of operation of the system will be verified in accordance with the manufacturer's installation, operation, and maintenance manuals

5.3002.4 Preparation for New Equipment—Low Rise Building

5.3002.4a Access

- A code-compliant walkway and service platform will be installed in attics as applicable, if not present
- Walkway and platform will be above the level of insulation if located in the attic

5.3002.4b Environmental hazards

- If suspected mold is found, workers shall attempt to determine the source and cause and identify potential repair issues. Mold-affected areas must be removed and certified free of mold by a licensed professional before HVAC equipment repair/replacement can begin
- If a friable asbestos-like substance is found to be present in an area that will be disturbed by work, it must be tested by a certified organization, and all system components and possible disturbed surrounding areas will be certified free of asbestos by a licensed professional before HVAC equipment repair/replacement can begin

5.3002.4c Disconnection of utilities

- Electricity and fuel will be turned off

5.3002.4d Refrigerant recovery

- Refrigerant will be recovered in accordance with 40 CFR 608 (www.epa.gov)
- All work will be done by a licensed professional or qualified person

5.3002.4e Disconnection of equipment

- Refrigerant lines, plumbing, ducts, electric, control wires, vents, and fuel supply will be disconnected
- All work will be done by a licensed professional

5.3002.4f Removal

- Equipment will be removed (e.g., furnace, air handler, evaporator, condensing unit)
- Equipment will be removed from the space without damaging property and disturbing or compressing the insulation
- Equipment will be disposed of in accordance with local ordinances and regulations

5.3002.7 Setting of Air Handler—Low Rise Building

5.3002.7a Location

- Equipment will be installed in a dry location within the conditioned space when feasible
- Equipment will be properly isolated from pollutant sources (e.g., garages)
- Equipment will be installed in a manner to provide ease of access for routine maintenance/service

- All work will be done by a licensed professional or qualified person

5.3002.7b Clearance

- Equipment will be installed with proper clearances in accordance with local codes and manufacturer specifications
- Alternative locations will be considered for equipment when existing locations are not suitable

5.3002.7c Connections

- Equipment will be installed so connections allow proper operation of the equipment and accessibility (e.g., electrical service, condensation drains, ductwork, fuel, venting, refrigerant lines)
- Equipment will be installed so the drain pan operates properly

5.3002.7d Support: horizontal airflow, attic

- Equipment will be supported with a non-wicking fireproof platform or suspended with a threaded rod in accordance with local codes and manufacturer specifications
- Equipment will be placed on vibration pads

5.3002.7e Support: horizontal airflow, basement, or crawlspace

- Equipment will be supported with a non-wicking, fireproof material or suspended with a threaded rod in accordance with local codes and manufacturer specifications
- Equipment will be placed on vibration pads/isolators

5.3002.7f Furnace support: upflow on a platform

- Equipment will be supported on nonflammable material capable of supporting the weight of the equipment
- Air handler opening will be free of obstructions
- Equipment will be placed on vibration pads/isolators

5.3002.7g Furnace support: downflow

- Equipment will be supported on ductwork capable of supporting the weight of the equipment
- Equipment will be supported on ductwork with rigid exterior insulation fastened to the ductwork

5.3002.7h Sealing

- Gaps larger than ¼" between air handler and adjoining ductwork or equipment (e.g., evaporator coil, filter rack) will be bridged with sheet metal, and sealed with mastic and fiberglass mesh
- All air handler joints will be sealed with mastic and fiberglass mesh
- Air handler joints and non-service openings will be sealed to eliminate all gaps with NFPA 90A and NFPA 90B approved sealant
- If unit is installed in a building cavity, the cavity must be sealed prior to the installation to eliminate any return air leaks from adjoining chases

5.3002.7i Drainage

- A secondary drain pan and drain line that provides proper pitch and a float switch will be installed beneath equipment located in areas where water damage may occur, such as attics and conditioned spaces
- Float switch will be interlocked with the cooling circuit to disable AC when leak occurs

5.3002.3 Sequence of Operation—Mid and High Rise Building

5.3002.3a Verification

- Sequence of system operation will be verified in accordance with the design documents, and the manufacturer's installation, operation, and maintenance manuals

5.3002.12 Cooling Equipment—Installation, Maintenance, and Commissioning—Mid and High Rise Building

5.3002.12a Chiller installation

- Maximum weight of refrigerant in a single space will be in compliance with ASHRAE
- Refrigerant monitors will be installed in accordance with ASHRAE
- Refrigerant relief valve will be piped to the outdoors and have an alarm
- Unit operational efficiencies will meet minimums as required by ASHRAE 90.1
- Structure will be able to support the unit
- Vibration isolators will be provided
- Manufacturer requirements will be followed when alternative storage methods for cooling towers are used (e.g., ice storage, ice tanks)

5.3002.12c Chiller commissioning

- Unit discharge temperature will be verified as called for by control system in accordance with the design documents
- Inlet and outlet temperatures to condenser will be maintained in accordance with the design documents
- Noise level will be maintained to be within designed criteria
- Safety switches will be verified to operate when unsafe conditions occur

5.3002.12d Split system installation

- Condensate will be piped to a properly sized sanitary drain
- Refrigerant type will be acceptable to the project type
- Unit operational efficiencies will meet minimums as required by ASHRAE 90.1
- Structure will be able to support the unit
- Each unit will be installed with a properly trapped condensate drain in accordance with manufacturer specifications (some situations require a pump)
- Primary heating of newly installed split systems will not be electric resistance heat
- Smoke detectors will be installed on systems that are greater than 2,500 cubic feet per minute (CFM)
- Appropriate lengths and elevations of refrigerant lines between condensing units and indoor coil will be used in accordance with manufacturer specifications
- Proper location (e.g., property lines, windows, units, outside air intakes) and clearances will be maintained in accordance with manufacturer specifications
- Environmental conditions will be considered when selecting and installing coils (e.g., special corrosion-protected units)

5.3002.12f Split system commissioning

- Proper operation of thermostats will be verified
- Carbon dioxide (CO_2) sensors will be calibrated
- Proper operation of smoke alarms will be verified

- Proper operation of mixed air damper will be verified
- If present, proper operation of heating valve will be verified
- Drains will be clear of debris and obstructions

5.3002.12g Package system unit installation

- Economizer (if installed) will be located away from pollutant sources
- Condensate will be piped to a properly sized sanitary drain
- Type of refrigerant will be verified as acceptable to the project type
- Economizer/power exhaust or relief dampers will be verified for proper function and operation
- Unit operational efficiencies will meet minimums as required by ASHRAE 90.1
- Structure will be able to support the unit
- Each unit will be installed with a properly trapped condensate drain in accordance with manufacturer specifications (some situations require a pump)
- New package systems will not have their primary heating be electric resistance heat
- Unit will be installed with CO2 control in high occupancy spaces (demand control ventilation)
- Smoke detectors will be installed on systems that are greater than 2,500 CFM
- Proper location (e.g., property lines, windows, units, outside air intakes) and clearances will be maintained in accordance

5.3002.12i Package system unit commissioning

- Before commissioning startup, test and balance reports will be provided
- Thermostats or building automation control will be verified to be functioning properly
- Properly working sequence of operations will be verified
- Properly functioning outdoor air, return air, supply air, CO2, and enthalpy sensor will be verified (if installed)
- Proper operation of mixed air damper will be verified
- Proper operation of reversing valve will be verified in heat pump units
- Drains will be clear of debris and obstructions
- Proper operation of motorized dampers will be verified
- In 3-phase units, the correct rotation of blower, condenser fans, and compressor will be verified
- Correct voltage level coming into unit will be verified
- Proper heating and cooling operation will be verified as in accordance with manufacturer specifications
- In heat pumps, proper defrost cycle operation will be verified
- Proper operation of safety switches will be verified

5.3002.12j Variable refrigerant flow (VRF) installation

- Building electrical characteristics, such as voltage and phase, will be checked to ensure proper equipment is selected
- Maximum weight of refrigerant in a single space will not exceed the maximum allowed by ASHRAE
- Total equivalent length of refrigerant piping will not exceed manufacturer rating
- Proper location and clearances will be maintained in accordance with manufacturer specifications

- Each unit will be installed with a condensate drain (some situations require a pump)
- Wall-mounted thermostats will be used
- Location of branch controller will be selected for non-occupied areas
- Outdoor air ventilation filter will be present

5.3002.12l VRF commissioning

- Thermostats will be verified to be functioning properly
- If installed, operation of ventilation damper will be verified
- Proper refrigerant charge will be verified
- Power supply will be verified (single phase units supply power from the outdoor units to the indoor units)

5.3002.12m Ductless mini split installation

- System will be a ductless mini split and not a VRF system
- Ductwork will not be installed
- Building phase will be checked to ensure proper equipment is selected
- Total equivalent length of refrigerant piping will not exceed manufacturer specifications
- Proper location and clearances will be maintained in accordance with manufacturer specifications
- Each unit will be installed with a condensate drain (some situations require a condensate pump)
- Wall-mounted thermostats will be used

5.3002.12o Ductless mini split commissioning

- Thermostats will be verified to be functioning properly
- Ventilation damper will be operational if outside air ducting is available, and airflow will be adjusted to provide the proper amount

5.3002.12p Package terminal air conditioner (PTAC) or package terminal heat pump (PTHP) installation

- PTAC sleeve will be sealed to envelope
- Condensate will be piped away from the building when required by manufacturer specifications
- Structure will be able to support the unit
- PTAC will be selected with outdoor air intake unless other ventilation strategy is present
- Each unit will be installed with a condensate drain (some situations require a pump)
- Environmental conditions will be considered when selecting and installing coils (e.g., special corrosion-protected units)

5.3002.12r PTAC or PTHP commissioning

- Thermostats will be verified to be functioning properly
- Ventilation damper will be operational if outside air ducting is available
- If present, proper operation of heating valve will be verified
- Drains will be clear of debris and obstructions

5.3002.12v Economizers installation

- Economizer, if installed, will be located away from pollutant sources

- Need for economizer outdoor air damper will be determined in accordance with ASHRAE 90.1 minimum requirements or local code
- Unit will be installed with carbon dioxide (CO2) control in high occupancy spaces (demand control ventilation)
- If unit economizer is part of fire life safety function, it will be tested for proper operation and control
- Economizer, power exhaust, or relief dampers will be verified for proper function and operation

5.3002.12x Economizers commissioning

- Properly working sequence of operations will be verified based on manufacturer specifications
- Proper operation of the outdoor air, return air, supply air, CO2, and enthalpy sensor will be verified based on manufacturers specifications
- Proper operation of mixed air damper will be verified based on manufacturer specifications
- Proper operation of motorized dampers will be verified based on manufacturer specifications
- Smoke detector and CO2 sensor interaction with the damper will be verified based on manufacturer specifications
- Pressure relief system will be verified as working when economizer is open

5.3002.12y Water source heat pump installation

- Condensate will be piped to a properly sized sanitary drain
- Type of refrigerant will be acceptable to the project type
- Unit operational efficiencies will meet minimums as required by ASHRAE 90.1
- Structure will be able to support the unit
- Each unit will be installed with a properly trapped condensate drain in accordance with manufacturer specifications (some situations require a condensate pump)
- Unit will be installed with CO2 control in high occupancy spaces (demand control ventilation)
- Smoke detectors will be installed on systems that are greater than 2,500 CFM
- Two-way valves will be installed that open when the thermostat calls for heating or cooling

5.3002.12aa Water source heat pump commissioning

- Thermostats will be verified to be functioning properly
- Proper operation of mixed air damper will be verified
- Proper operation of two-way valve will be verified
- Drains will be clear of debris and obstructions

5.3002.12ab Fan coil units installation

- Four-pipe systems, where applicable, will be installed in order to take advantage of simultaneous heating and cooling
- Condensate will be piped to a properly sized sanitary drain
- Adequate structural support will be verified for unit
- Each unit will be installed with a properly trapped condensate drain in accordance with manufacturer specifications (some situations require a pump)
- Unit will be installed with CO2 control in high occupancy spaces (demand control ventilation)

- Filtration minimum efficiency reporting value (MERV) level will be appropriate for type of space and equipment
- If the building operates with a pneumatic system, the following components will be serviced and maintained:
  - Air compressor
  - Air dryer system
  - Thermostats
  - Actuators
  - Receiver controllers
  - Sensors
  - Miscellaneous components such as pneumatic electric, electric pneumatic solenoid, and solenoid switches

5.3002.12ad Fan coil units commissioning

- Thermostats will be verified to be functioning properly
- If applicable, proper operation of heating and cooling valve will be verified
- Drains will be clear of debris and obstructions

5.3002.12ae Wall furnace installation

- Penetrations through exterior walls will be sealed with the appropriate air sealing material
- Adequate structural support will be verified for unit
- A carbon monoxide detector will be installed in the rooms where the wall furnace is located
- Filtration MERV level will be appropriate for type of space and equipment

5.3002.12ag Wall furnace commissioning

- Thermostats will be verified to be functioning properly
- Filters will be verified to be clear of debris
- Temperature rise will be within manufacturer specifications
- Gas pressure will be within manufacturer specifications
- A combustion analysis test will be performed and documented

5.3002.13 Preparation for New Equipment—Mid and High Rise Building

See Preparation for New Equipment—Low Rise Building above for Low Rise Building

5.3002.16 Setting of Air Handler—Mid and High Rise Building

See Setting of Air Handler—Low Rise Building above for Low Rise Building

5.3003 Heating/Cooling System Assessment

5.3003.17 Data Plate Verification—Low Rise Building

5.3003.17a Data plate verification

- Equipment will be visually inspected
- Information will be recorded from the indoor and outdoor equipment data plates
- Information will be entered into the operations and management manual

5.3003.18 CO and Fuel Oil Leak Detection—Low Rise Building

5.3003.18a Carbon monoxide (CO) detection

- Personal CO alarm will be worn in accordance with Building Performance Institute (BPI) standards

5.3003.18b Gas leak detection

- Gas pipes will be tested for leaks with an electronic combustible gas leak detector and verified with bubble solution
- When installing new gas lines a code approved standing pressure test will be conducted to detect leaks

5.3003.18c Fuel oil leak detection

- Oil tank, piping and equipment will be visually inspected for oil leaks
- Fuel oil tanks will be inspected for leaks and corrosion

5.3003.19 Refrigerant Line Inspection—Low Rise Building

5.3003.19a Insulation

- All refrigerant lines will be insulated based on the equipment manufacturer's requirements in conformance with applicable code adopted by the jurisdiction
- All installed insulation will be properly sealed

5.3003.19b Ultraviolet (UV) protection of insulation

- If exposed to sunlight, refrigerant line insulation will be protected from UV degradation

5.3003.19c Sizing of refrigerant lines

- Refrigerant lines will be sized to meet manufacturer specifications for the installed equipment

5.3003.19d Installation quality of refrigerant lines

- Refrigerant lines will be installed without kinks, crimps, or excessive bends
- Refrigerant lines will be joined together using manufacturer-approved method(s)
- Proper filter dryer(s) will be installed
- Refrigerant lines will be checked for leaks following EPA Section 608 and verified leak free before refrigerant charging
- Proper evacuation and dehydration techniques will be employed prior to refrigerant charging

5.3003.19e Support for refrigerant lines

- Refrigerant lines will be routed, supported, and secured to the building in a manner that protects the line from damage by workers or occupants

5.3003.20 Electrical Service—Low Rise Building

5.3003.20a Polarity

- Polarity of the equipment will be correct

5.3003.20b Voltage: incoming power

- Voltage, phase, and frequency will be in accordance with manufacturer specifications

5.3003.20c Wire size

- Wire size should be appropriate for the equipment installed

5.3003.20d Service disconnect for multi-family building

- The proper service disconnect will be installed, and if fused, the correct fuses will be installed

5.3003.20e Voltage: contactor for multi-family building

- Voltage drop will be within acceptable range in accordance with manufacturer specifications

5.3003.20f Grounding

- Adequate grounding will be present

5.3003.20g Blower amperage

- Amperage will be within original equipment manufacturer (OEM) specifications and/or code requirements

5.3003.20h Compressor amperage for multi-family building

- Amperage will be within OEM specifications and/or code requirements

5.3003.20i Door switch operation

- Blower compartment safety switch operation will be verified

5.3003.20j Heat pump: emergency heat

- Emergency heat circuit functions will be verified
- Amperage will be within OEM specifications and/or code requirements

5.3003.21 Measuring Airflow—Low Rise Building

5.3003.21a Validate air distribution system installation

- System will be checked for existence of specified system components

5.3003.21b Testing equipment selection

- Measurement equipment will be selected so that design value will be within the accurate range of the measuring device
- Equipment will be capable of accurately measuring +/-10% in general case
- Measurement equipment will be calibrated and field checked in accordance with manufacturer recommendations

5.3003.21c Test air handler unit

- Equipment testing will check for:
  - Proper operation (programmed schedule/sequence of operation)
  - Proper rotation
  - Filter condition
  - All measured values will be recorded and compared against design specifications
- Fan flow will be adjusted to meet design specification

5.3003.21d Total airflow—approved equipment

- Total system airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements

- Examples of acceptable methods to test airflow include the following:
  - Temperature rise test
  - Airflow plate (e.g., TrueFlow® Air Handler Flow Meter)
  - Fan pressurization device (e.g., Duct Blaster®, DuctTester)
  - Hot wire anemometer

5.3003.21e External static pressure

- External static pressure will be in accordance with manufacturer specifications

5.3003.21f Pressure drop: coil

- Pressure drop across cooling coils will be in accordance with manufacturer specifications

5.3003.21g Pressure drop: filter

- Pressure drop across filter will be in accordance with manufacturer specifications

5.3003.21h Balance of room flow: new ductwork

- Airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements
- Examples of acceptable methods include the following:
  - Airflow will be measured at each register and compared to load calculation to ensure proper airflow delivery
  - Adjustments will be made to fan speed, dampers, and registers until design specifications are met

5.3003.21i Supply wet bulb and dry bulb

- Supply wet bulb and dry bulb air temperatures will be recorded

5.3003.21j Return wet bulb and dry bulb

- Return wet bulb and dry bulb air temperatures will be recorded

5.3003.21k Temperature rise: gas and oil furnaces only

- Temperature rise between the supply and return will be in accordance with manufacturer specifications

5.3003.21l Final HVAC equipment balance

- Final airflow and/or pressure will be measured, confirmed, and recorded at air handler and registers
- Airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements

5.3003.21m Occupant/building manager education

- Occupant/property manager will be instructed on proper operation and maintenance procedures

5.3003.22 Combustion Analysis—Low Rise Building

5.3003.22a Testing equipment selection

- Measurement equipment will be selected so that design value will be within the accurate range of the measuring device
- Equipment will be capable of accurately measuring +/-10% in general case

- Measurement equipment will be calibrated and field checked in accordance with manufacturer recommendations

5.3003.22b Combustion analysis protocol

- Combustion analysis will be performed in accordance with manufacturer specifications, Appendix A Combustion Appliance Safety Protocol and ANSI/ACCA Standard 5

5.3003.22c Fuel oil system: nozzle size

- Nozzle size/spray angle/spray pattern will be correct for design input and within equipment firing rate of the heating system manufacturer

5.3003.22d Natural gas/propane system: burner orifice(s) size

- Burner orifice(s) size will be in accordance with manufacturer specification

5.3003.22e Combustion air adjustment

- Combustion air setting will be in accordance with manufacturer's recommendations and modified based on combustion analysis testing

5.3003.22f Fuel pressure/gas pressure

- Measurement will be verified in accordance with manufacturer specifications

5.3003.22g Fuel oil system: smoke test (this test must be conducted before any combustion testing has started)

- Smoke spot reading will be in accordance with burner manufacturer specifications
- If smoke spot test is higher than manufacturer specifications, a steady state efficiency test will not be performed until the unit has been cleaned and tuned

5.3003.22h Steady state efficiency (SSE)

- Once burner has run for five to ten minutes, perform an SSE test with a properly calibrated combustion analyzer
- Measurement will be verified in accordance with manufacturer specifications

5.3003.22i Net stack temperature

- Net stack temperature will be measured and verified in accordance with manufacturer specifications

5.3003.22j Carbon dioxide (CO2) and oxygen

- Measurement will be verified in accordance with industry manuals (e.g., Testo, Bacharach) and manufacturer specifications

5.3003.22k Excess air

- Excess air will be calculated and shown in accordance with industry manuals (e.g., Testo, Bacharach) and manufacturer specifications

5.3003.22l Carbon monoxide (CO) in flue gas

- CO in the undiluted flue gas will be less than level specified in the applicable subsection of the ANSI Z21 standard

5.3003.23 Refrigerant Charge Evaluation—Low Rise Building

5.3003.23a Verification of refrigerant charge

- Equipment must be installed in accordance with written specifications and manufacturer specifications

- Proper airflows and/or water flows through the heat exchanger will be within manufacturer specifications before refrigerant evaluation can be performed
- The system will be within the manufacturer permissible temperature tolerances and in steady state condition before refrigerant evaluation can be performed

5.3003.23b Testing equipment

- Measurement equipment will be calibrated and field checked in accordance with manufacturer recommendations
- Measurement equipment will be selected so that design value (pressure and temperature) will be within the accurate range of the measuring device

5.3003.23c Testing procedure

- Refrigerant charge will be verified in accordance with ANSI/ACCA Standard 5
- Examples of acceptable methods include the following:
  - Superheat test done under outdoor ambient temperatures specified by the manufacturer. Superheat value must be within +/-5°F of the manufacturer-specified superheat value (or within manufacturer-recommended tolerances)
  - Subcooling test done under outdoor ambient temperatures specified by the manufacturer. Subcooling value must be within +/-3°F of the manufacturer-specified subcooling value (or within manufacturer-recommended tolerances)
  - Any method approved and specifically documented by the manufacturer that will ensure proper refrigerant charge
- All work will be done by a licensed professional or qualified person

5.3003.23d Documentation

- Documentation will be done in accordance with ANSI/ACCA Standard 5
- Documented field data (including, but not limited to, operating refrigerant pressures, superheat and subcooling values, etc.), and operating conditions will be recorded at time of testing

5.3003.24 Evaporative Cooler Maintenance and Repairs—Low Rise Building

5.3003.24a Assessment and diagnosis

- The following evaporative cooling system elements will be assessed:
  - Pump
  - Pan
  - Spider
  - Float
  - Damper
  - Roof jack, roof supports
  - Water line, water valve
  - Electrical
  - Pads
  - Motor
  - Fan
- Elements will be repaired or replaced as needed

5.3003.24b Evaporative cooler repair

- Calcium deposits will be removed
- Pads will be replaced

- Any additional repairs or part replacements will be made as necessary
- Equipment will operate in accordance with local codes and standards

5.3003.24c Building manager education

- A regular service schedule will be recommended to the building manager
- Issues regarding multiple systems running will be discussed with occupant
- Building manager will be advised that system should be drained at the end of the cooling season

5.3003.34 Fuel Delivery System for Natural Gas and Propane—Low Rise Building

5.3003.34a Material and support

- An approved pipe type in accordance with NFPA will be installed and supported
- Manual gas shut-off valve, union joint, and drip leg will be verified or installed
- All work will be done by a licensed professional or qualified person

5.3003.34b Gas pipe sizing

- Gas pipes (building main and equipment drops) will be installed for the total connected load of all appliances in accordance with NFPA
- All work will be done by a licensed professional or qualified person

5.3003.34c Gas pipe sealant

- Pipes will be sealed with an approved fastening process and sealant in accordance with manufacturer specifications
- Gas lines will be leak free when tested with an electronic combustible gas leak detector and verified with bubble solution
- Gas lines will be leak free when tested by local code-approved standing pressure test
- All work will be done by a licensed professional, or qualified person

5.3003.35 Combustion Appliance Venting System—Low Rise Building

5.3003.35a Combustion air

- Combustion supply/exhaust air opening will be in compliance with applicable NFPA standards (NFPA 31 or NFPA 54/ANSI/AGA Z223.1) or applicable local code

5.3003.35b Flue vent material

- Flue vent material will be selected to prevent flue gas freezing and/or corrosion (using double wall, where necessary)
- Cost-effective materials will be used when appropriate and allowable

5.3003.35c Installation

- Venting systems will be installed considering proper material, pitch, common venting, chimney liner, clearance, total equivalent length, and termination in accordance with NFPA 54, 31, 211
- Category I venting systems will be installed in accordance with NFPA 54/ANSI Z223.1
- Category III and IV venting systems will be installed in accordance with the manufacturer specifications
- Terminations will be located away from windows, doors, and walkways
- Aesthetics and noise will be considered

- Venting will be routed in the shortest and most direct path possible
- Vent joints will be airtight and watertight to prevent flue gas and condensation leakage

5.3003.35d Orphaned equipment

- Existing vent system or chimney will be resized or relined in accordance with the applicable NFPA standard when one or more common vented appliances are removed (orphaned)

5.3003.36 Ductwork System—Low Rise Building

5.3003.36a Indoor (supply ducts) duct section located completely within the thermal boundary

- Duct material will be installed with an R-value compliant with code
- An appropriate vapor retarder will be installed

5.3003.36b Outdoor duct section located outside of the thermal boundary

- Duct material will be selected that meets the following criteria:
  - An insulation level compliant with code
  - Permeability that prevents condensation
  - Permeability that reduces heat loss or gain from the ductwork

5.3003.36c Building cavities used as ductwork

- When viable building cavities used as ductwork will be replaced with properly sized conventional duct material
- When replacement is not an option, building cavities used as ductwork will be sealed when accessible

5.3003.36d Fire rating

- Ducts will be installed in accordance with the fire rating of local codes

5.3003.36e Penetrations

- Interior wall penetrations for ductwork will be sealed with a durable sealant (e.g., caulk, silicone, foam)
- When allowed by the local jurisdiction, existing penetrations through fire walls and floors will be sealed with a fire-rated material

5.3003.36f Support

- Ductwork will be supported in a manner that does not constrict ductwork or duct insulation per SMACNA duct construction standards, the Air Diffusion Council [ADC] for flexible duct, or the North American Insulation Manufacturers Association [NAIMA] for fiberglass duct

5.3003.36g Protection

- Ducts will be routed such that service and repair to the building and its systems does not damage the ducts

5.3003.36h Fastening: metal to flexible duct

- Flexible duct-to-metal connections will be fastened with tie bands using a tie band tensioning tool
- Beaded collars will be installed for all sheet metal to flexible duct connections
- Mastic will be applied to interior flex lining to metal connection
- Manufacturer specifications will be followed

5.3003.36i Fastening: metal to metal

- Metal-to-metal connections will be fastened with equally spaced mechanical fasteners
- Gaps larger than ¼" will be bridged with sheet metal
- Joints will be sealed with mastic
- Joints smaller than ¼" will be sealed with NFPA 90A and B approved sealant

5.3003.36j Fastening: duct board to metal

- Duct board to metal connections will be fastened with mechanical fasteners
- Joints and connections will be sealed with UL 181A listed tapes or mastics

5.3003.36k Fastening: boot to building connection

- Boots will be fastened to the building with mechanical fasteners
- Connection will be sealed with mastic, caulk, or gaskets

5.3003.36l Terminations

- Terminations capable of delivering air with proper speed and throw of 80-120% of the farthest wall, floor, or ceiling will be selected
- Selections will be based on ANSI/ACCA Manual T Air Distribution Basics

5.3003.36m Filtration

- Filter bypasses will be eliminated
- Filters will be changed
- Filters with high static pressure drops will be avoided
- A visual inspection for excessive dust and debris will be performed

5.3003.36n External static pressure

- Ductwork, filter, and other equipment will be installed so total external static pressure does not exceed manufacturer specifications

5.3003.36o Airflow: cooling and heat pump systems

- Measured airflow per ton will meet manufacturer specifications
- Airflow will be established in accordance with ANSI/ACCA 5 QI HVAC Quality Installation Specification and ASHRAE Standards

5.3003.36p Temperature rise: heating-only systems

- Temperature rise will be measured, and the result will be in accordance with manufacturer specifications

5.3003.36q System protection during construction and renovation

- Registers, grilles, and diffusers will be blocked, masked, or otherwise sealed with a durable material
- Use of system will not be allowed during renovation or construction
- Contractor and occupant will be educated on necessity of protecting the equipment

5.3003.36r Room pressure balancing

- An appropriate means of pressure balancing will be installed (e.g., transfer grilles, jumper ducts, individual room returns)
- Room-to-room pressure differences shall not exceed +/-3 Pa with the air handler running

5.3003.36s Sealing: new ductwork

- Total system leakage (including air handler) will not exceed 6% of designed system airflow (cubic feet per minute) when tested at 25 Pa in accordance with the California Mechanical Code
- For partial duct system replacement or improvement, existing ductwork specification will be applied (no more than 15% in the California Mechanical Code)

5.3003.36t Sealing: existing ductwork

- Accessible joints, cracks, seams, holes, and penetrations will be sealed

5.3003.37 Heating and Cooling Controls—Low Rise Building

5.3003.37a Removal of mercury-based thermostats

- Mercury-based thermostats will be removed safely and disposed of in accordance with EPA regulations

5.3003.37b Removal of existing controls

- Existing controls will be removed in accordance with EPA lead-safe work rules

5.3003.37c Penetrations

- Penetrations for control wiring will be sealed with a durable sealant (e.g., caulk, silicone)
- Penetrations through fire walls will be sealed with a fire-rated material

5.3003.37d Thermostat location

- Thermostats will be installed to reflect the temperature of the zone in which they are installed
- Thermostats will not be exposed to extreme temperatures, radiant heat sources, warm/cold walls, and drafts

5.3003.37e Blower speed

- Total airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements

5.3003.37f Thermostat selection: heat pump

- A thermostat with equipment supplementary heat lockout that can interface with an outdoor temperature sensor will be selected

5.3003.37g Heat pump: supplementary heat

- Thermal and economic balance point will be calculated and an optimum thermal balance point will be selected in accordance with ANSI/ACCA Manual S
- The design of variable refrigerant flow systems are permitted to not require supplementary heat

5.3003.37h Heat pump: outdoor temperature sensor

- An outdoor temperature sensor will be installed in accordance with manufacturer specifications

5.3003.37i Heat pump: supplementary heat control wiring

- Supplementary heat will be wired onto second stage heating terminal (W2)

5.3003.37j Thermostat: installer programming

- The installer options will be set to match the thermostat to the equipment and control board settings

5.3003.37k Time delay settings

- Time delay for equipment will be set in accordance with manufacturer specifications and as appropriate for the climate zone (e.g., no time delay for hot humid climates)

5.3003.37m Occupant/building manager education

- Occupant/building manager will be educated on proper use of thermostat, including:
  - Proper use of setbacks for air conditioners and heat pumps
  - Allowing occupant comfort to determine setback for combustion-heating appliances
  - Using emergency heat appropriately

5.3003.37n Central controller

- Wiring and sensors will be installed in accordance with manufacturer specifications

5.3003.38 Condensate Drainage of HVAC Equipment—Low Rise Building

5.3003.38a Connection

- Connections in condensate drain system will be watertight

5.3003.38b Insulation

- Condensate drain lines will be insulated with a minimum 1" of insulation with a vapor retarder

5.3003.38c Overflow protection: up flow

- Secondary drain pan and float switch will be installed when overflow could damage finished surfaces or up flow systems will have a float switch installed in the primary condensate drain when overflow could damage finished surfaces
- Float switch will be interlocked with the cooling circuit and will break the circuit when a leak occurs

5.3003.38d Pumps

- Condensate drain pumps will be installed when condensate cannot be drained by gravity
- Power source for pumps will be installed
- Operation and drainage of pump will be verified

5.3003.38e Vents and traps

- Vents and traps will be installed on condensate drain lines, including condensing heating systems in accordance with manufacturer specifications
- For combustion-heating equipment, trap supplied with the equipment will be used in accordance with manufacturer specifications

5.3003.38f Drain pan

- A secondary drain pan will be installed for all air conditioning, air handler, or evaporator coil installations where water damage may occur
- The secondary pan will contain a drain, which will be ran separately from the primary condensate drain to a visible termination point
- The secondary drain pan will be pitched toward the drain line to ensure that moisture is removed from the building

5.3003.38g Water level detection device

- All secondary drain pans will have a water level detection device interlocked with the cooling control circuit that shuts down the unit when a leak occurs

5.3003.38h Termination

- Condensate drain will be terminated in accordance with local codes

5.3003.25 Refrigerant Line Inspection—Mid and High Rise Building

See Refrigerant Line Inspection—Low Rise Building

5.3003.26 Electrical Service—Mid and High Rise Building

See Electrical Service—Low Rise Building

In addition, the following shall apply:

5.3003.26j Heat pump: electric strip heat

- Amperage will be within OEM specifications and/or code requirements (in accordance with the NFPA 70A and 70E standards)

5.3003.26k Heat pump: emergency heat

- Emergency heat circuit functions will be verified
- Amperage will be within OEM specifications and/or code requirements (in accordance with the NFPA 70A and 70E standards)

5.3003.27 Measuring Airflow—Mid and High Rise Building

5.3003.27a Validate installation of air distribution system

- System will be checked for existence of specified system components

5.3003.27b Testing equipment selection

- Measurement equipment will be selected so that design value will be within the accurate range of the measuring device
- Equipment will be capable of accurately measuring +/-10% in general case
- Measurement equipment will be calibrated and field checked in accordance with manufacturer recommendations

5.3003.27c Test main fan or air handler

- Equipment testing will check for:
  - Proper operation (schedule/sequence of operation)
  - Proper rotation
  - Filter condition
  - Total flow at fan

5.3003.27d Measure airflow at terminals (commissioning)

- Airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet the design requirements
- Testing/validation will be performed by certified test and balance technicians (certified by NEBB [National Environmental Balancing Bureau] and/or AABC or equivalent)

5.3003.27e Supply wet bulb and dry bulb

- Supply wet bulb and dry bulb air temperatures will be recorded

5.3003.27f Return wet bulb and dry bulb

- Return wet bulb and dry bulb air temperatures will be recorded

5.3003.27g Thermostat wet bulb and dry bulb

- Thermostat wet bulb and dry bulb air temperatures will be recorded

5.3003.27h System adjustment

- Airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet the design requirements
- Adjustments will be made to:
  - Fan speed (via sheave adjustment, replacement, and/or variable frequency drive motor replacement)
  - Dampers
  - Registers

5.3003.27i Final balance

- Final airflow and/or pressure will be measured and confirmed at air handler and registers
- Airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet the design requirements

5.3003.27j Occupant/building manager education

- Occupant/property manager will be educated on proper operation and maintenance procedures

5.3003.28 Compressor—Mid and High Rise Building

5.3003.28a Sizing of a compressor

- Compressor will be properly sized for the existing equipment and evaluated in accordance with ANSI/ACCA Standard 5

5.3003.28b Location

- Compressor will be located in an area that is on a level surface and that provides adequate ventilation

5.3003.28c Refrigerant piping

- Suction line will be properly sized
- Refrigeration tubing will be used
- Inert gas will be trickled through piping when brazing joints together
- Filter dryer will be installed
- P-type oil traps will be located at the base of suction line riser
- Proper evacuation and dehydration procedures will be followed
- Horizontal runs will be sloped 1" per 20' toward the compressor
- Vibration absorbers may be used and installed in accordance with manufacturer specifications

5.3003.28d Electrical

- Field wiring will be installed in accordance with NFPA 70 National Electric Code and local codes
- Proper voltage, frequency, and phase will coincide with the nameplate

5.3003.28e Compressor startup

- All electrical connections will be tight
- All safety controls will be installed and operational

- Oil level will meet manufacturer-recommended level
- Only approved refrigerant oil will be used
- Proper refrigerant charge will be verified by approved methods
- Refrigerant type and amount will be documented

5.3003.30 Refrigerant Charge Evaluation—Mid and High Rise Building

See Refrigerant Charge Evaluation—Low Rise Building

5.3003.32 Evaporative Cooler Maintenance and Repairs—Mid and High Rise Building

See Evaporative Cooler Maintenance and Repairs—Low Rise Building

5.3003.39 Fuel Delivery System for Natural Gas—Mid and High Rise Building

5.3003.39a Location, material, and support

- An approved pipe type in accordance with NFPA 54/ANSI/AGA Z223.1 will be installed and supported
- Gas train will be located/installed to not create a trip hazard or be damaged by water
- All work will be done by a licensed professional or qualified person

5.3003.39b Size

- Gas pipes (building main and equipment drops) will be installed for the total connected load of all appliances in accordance with NFPA 54/ANSI/AGA Z223.1
- Existing gas piping will provide appropriate pressure and supply rate for heating equipment in accordance with scope of work
- All work will be done by a licensed professional

5.3003.39c Installation

- Pipe routing will create the least pressure drop
- Gas pressure regulators requiring venting will be vented to outside the building with a rigid pipe
- Gas train components, pipe material, and pipe sizing will comply with all applicable codes and standards (AGA, NFPA)
- Pipes will be sealed with an approved fastening process and sealant in accordance with manufacturer specifications
- All work will be completed by a licensed professional

5.3003.39d Testing

- For newly installed systems, gas train will be pressure tested for leaks
- For existing systems, gas train will be tested for leaks in accordance with local utility requirements
- Gas pressure and supply rates will be tested to confirm they comply to specified scope of work and burner requirements
- All work will be supervised by a licensed professional

5.3003.39e Education

- Property manager will be educated on the operation of the high and low gas pressure switches, gas valve, and gas regulator

- Property manager will be educated on the indications of raw gas leaks

5.3003.41 Combustion Appliance Venting System—Mid and High Rise Building

See Combustion Appliance Venting System—Low Rise Building

Exception: Orphaned appliances policy does not apply to mid/high rise building

5.3003.42 Ductwork System—Mid and High Rise Building

5.3003.42a Indoor (supply) duct section located completely within the thermal boundary

- Duct material will be installed with an R-value compliant with code
- An appropriate vapor retarder will be installed

5.3003.42b Outdoor duct section located outside of the thermal boundary

- Duct material will be selected that meets the following criteria:
  - An insulation level compliant with code
  - Permeability that prevents condensation
  - Permeability that reduces heat loss or gain from the ductwork

5.3003.42c Exterior, outdoor duct is exposed to the elements (sun, rain, wind, heat, cold, etc.)

- Duct material will be selected that meets the following criteria:
  - An insulation level compliant with code
  - A weatherproof barrier that is resistant to ultraviolet light damage

5.3003.42d Fire rating

- Ducts will be installed in accordance with the fire rating required by local codes

5.3003.42e Duct supports

- Ductwork will be supported in a manner that does not constrict ductwork or duct insulation per SMACNA duct construction standards, ADC for flexible ducts, or NAIMA for fiberglass ducts

5.3003.42f Protection

- Ducts will be routed such that service and repair to the building and its systems does not damage the ducts

5.3003.42g Fastening metal to flexible duct

- Flexible duct-to-metal connections will be fastened with tie bands using a tie band
- Beaded collars will be installed for all sheet metal to flexible duct connections
- Mastic will be applied to interior flex lining to metal connection
- Manufacturer specifications will be followed

5.3003.42h Fastening metal to metal

- Metal-to-metal connections will be fastened with mechanical fasteners
- Gaps larger than ¼" will be bridged with sheet metal
- Joints will be sealed with mastic
- Joints smaller than ¼" will be sealed with NFPA 90A and B approved sealant

5.3003.42i Fastening duct board to metal

- Duct board to metal connections will be fastened with mechanical fasteners

- Joints and connections will be sealed with UL 181A listed tapes or mastics

5.3003.42j Fastening boot to building connection

- Boots will be fastened to the building with mechanical fasteners
- Connection will be sealed with mastic, caulk, or gaskets

5.3003.42k Terminations

- Terminations capable of delivering air with proper speed and throw of 80-120% of the farthest wall, floor, or ceiling will be selected
- Terminations will have a noise criteria level less than 30 decibels

5.3003.42l Filtration

- Filter bypasses will be eliminated
- Filters will be changed

5.3003.42m External static pressure

- Ductwork, filter, and other equipment will be installed so that total external static pressure does not exceed manufacturer specifications

5.3003.42n Airflow: cooling and heat pump systems

- Measured airflow per ton will meet manufacturer specifications
- Airflow will be established in accordance with ANSI/ACCA 5 QI HVAC Quality Installation Specification and ASHRAE standards

5.3003.42o Temperature rise: heating only systems

- Temperature rise will be measured, and the result will be in accordance with manufacturer specifications

5.3003.42p System protection during construction and renovation

- Registers, grilles, and diffusers will be blocked, masked, or otherwise sealed with a durable material
- Use of system will not be allowed during renovation or construction
- Contractor and occupant will be educated on necessity of protecting equipment

5.3003.42q Room pressure balancing

- An appropriate means of pressure balancing will be installed (e.g., transfer grilles, jumper ducts, individual room returns)
- Room-to-room pressure differences shall not exceed +/-3 Pa with the air handler running

5.3003.42r Sealing: new ductwork

- Total system leakage (including air handler) will not exceed 6% of designed system airflow (cubic feet per minute) when tested at 25 Pa in accordance with the California Mechanical Code
- (For partial duct system replacement or improvement, existing ductwork specification will be applied)

5.3003.42s Sealing: existing ductwork

- Accessible joints, cracks, seams, holes, and penetrations will be sealed to 15% or less in accordance with the California Mechanical Code

5.3003.43 Heating and Cooling Controls—Mid and High Rise Building

See Heating and Cooling Controls—Low Rise Building

5.3088 Special Heating/Cooling Considerations

5.3088.2 Regional Climatic Considerations—Low Rise Building

When heating or cooling replacement is required by program policy, the following climate temperature considerations in the area the appliance will be installed shall be observed:

5.3088.2a Very cold climates

- Condensate line will be insulated
- Verification of proper charge will be conducted when outdoor temperatures are suitable
- Refrigerant charge evaluation will use proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5
- Refrigerant will be weighed into heating, ventilation, and air-conditioning (HVAC) systems when outdoor temperatures do not facilitate accurate testing of system charge

5.3088.2b Cold climate

- Condensate line will be insulated
- Verification of proper charge will be conducted when outdoor temperatures are suitable
- Refrigerant charge evaluation will be done using proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5
- Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge

5.3088.2e Marine/coastal climate

- Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge
- Verification of proper charge will be conducted when outdoor temperatures are suitable
- Refrigerant charge evaluation will be done using proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5

5.3088.2f Hot, dry climate

- Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge
- Verification of proper charge will be conducted when outdoor temperatures are suitable
- Refrigerant charge evaluation will be done using proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5

5.3088.3 Regional Climatic Considerations—Mid and High Rise Building

When heating or cooling replacement is required by program policy, the following climate temperature considerations in the area the appliance will be installed shall be observed:

5.3088.3a Very cold climates

- Individual rooms will remain at a pressure differential of no greater than +/-3 Pa with reference to the indoors
- Combustion inlets and outlets will be terminated above snow line and protected from snow cover
- Roof exhaust fans will be installed with roof curbs that meet or exceed the mechanical code requirements
- Proper refrigerant charge will be evaluated and documented according to ANSI/ ACCA Standard 5
- Examples of acceptable procedures that may be performed include:
  - Refrigerant will be weighed into heating, ventilation, and air conditioning (HVAC) systems when outdoor temperatures do not facilitate accurate testing of system charge
  - Verification of proper charge will be conducted when outdoor temperatures are suitable
- Refrigerant charge evaluation must use proper evaluation techniques (subcooling/ superheat) depending on metering device in accordance with ANSI/ACCA Standard 5

5.3088.3b Cold climates

- Combustion inlets and outlets will be terminated above snow line and protected from snow cover
- Roof exhaust fans will be installed with roof curbs that meet or exceed the mechanical code requirements
- Proper refrigerant charge will be evaluated and documented according to ANSI/ ACCA Standard 5
- Examples of acceptable procedures that may be performed include:
  - Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge
  - Verification of proper charge will be conducted when outdoor temperatures are suitable
  - Refrigerant charge evaluation must use proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ ACCA Standard 5

5.3088.3e Marine/coastal climate

- Proper refrigerant charge will be evaluated and documented according to ANSI/ ACCA Standard 5
- Examples of acceptable procedures that may be performed include:
  - Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge
  - Verification of proper charge will be conducted when outdoor temperatures are suitable
  - Air conditioning/heating coils that are to be installed outside will be selected to withstand corrosion

5.3088.3f Hot, dry climate

- Proper refrigerant charge will be evaluated and documented according to ANSI/ ACCA Standard 5

- Examples of acceptable procedures that may be performed include:
  - Refrigerant will be weighed into HVAC systems when outdoor temperatures do not facilitate accurate testing of system charge
  - Verification of proper charge will be conducted when outdoor temperatures are suitable
  - Refrigerant charge evaluation must be done using proper evaluation techniques (subcooling/superheat) depending on metering device in accordance with ANSI/ACCA Standard 5
- Heating and cooling refrigerant lines will be insulated

5.3100 Hydronic Heating (Hot Water and Steam Systems)

5.3101 Design

When feasible as a measure, the multi-family system design, system repairs, and system replacements shall conform with applicable state and local codes.

5.3102 Equipment Installation

5.3102.1 Replacement Hot Water Boilers

5.3102.1a Assessment of multi-family boiler system

- Confirmation of the scope of work will be made for the following:
  - Clearances
  - Proper drainage in boiler room
  - Flue/chimney conditions
  - Electrical capacity
  - Oil/gas availability
  - Piping connections

5.3102.1b Boiler sizing calculation

- Heat load calculations will be confirmed based on ACCA Manual J (for residential applications), Manual N, or ASHRAE equivalent (for commercial applications) and ASHRAE Standard 183 (for high rise application)
- Sizing will be confirmed for combined space heating and domestic hot water plant

5.3102.1c Low mass selection

- Low mass (water volume and heat exchanger) boilers will be selected whenever possible
- A primary/secondary piping configuration will be utilized when low mass systems are selected
- A low loss header will be utilized for primary/secondary piping configurations

5.3102.1d Multiple boilers/sequencing

- Boiler control package will be used for outdoor water reset, lead-lag, and sequencing capabilities
- An authorized boiler manufacturer technician will be responsible to set up and demonstrate/ensure optimal sequencing and lead-lag operation

5.3102.1e Fuel switching

- Allowed only when savings-to-investment ratio (SIR) for the fuel switching is ≥ 1.0

- Chimney will be assessed for proper sizing, lining, and draft

5.3102.1f Hazardous material removal

- Health concerns in the removal and replacement of equipment will be identified
- Written notification of hazardous material will be provided to the property manager/ occupant
- Contact information for the regional EPA asbestos coordinator will be provided
- Asbestos abatement will be conducted by an EPA-certified contractor before decommissioning and replacement
  - Property manager/occupant will be asked to contract with an EPA-certified asbestos contractor to conduct asbestos removal

5.3102.1g Decommissioning

- Accepted industry procedures and practices will be followed to:
  - Remove old boiler and associated components
  - Seal any unused chimneys
  - Remove unused oil tank, piping, valves, and associated equipment

5.3102.1h New equipment installation

- New boiler and associated components will be installed in compliance with ANSI/ ACCA Standard 5 acceptable procedures and local mechanical codes
- Concrete pads will be in accordance with the Uniform Mechanical Code and local building codes
- All required operating and safety controls and boiler trim will be installed and set up in accordance with local code and manufacturer's requirements
- Water meter will be installed on the makeup water/incoming line to the boiler
- Isolation valves will be installed to allow for pressure testing of the boiler
- Hydrostatic testing (for site-built boilers) will be performed to confirm there are no water leaks in boiler

5.3102.1i Flushing of system

- Flush valve will be installed at the lowest point
- With the boiler isolated and the feed and flush valves open, keep feeding water to the system until drain water runs clear

5.3102.1j Startup/skimming of boiler

- When applicable, new boiler will be flushed and skimmed before hot water is released to the building for the first time in accordance with manufacturer specifications
- Startup will be performed in accordance with manufacturer specifications
- Combustion efficiency and safety testing will be performed at multiple firing rates:
  - At two firing rates for "low- high-low" burners, and
  - Minimum three firing rates for fully modulating burners
- Post-installation test report will include:
  - Outdoor temperature
  - Draft
  - Carbon monoxide (ambient and in flue gases)
  - Oxygen (in flue gases)
  - Flue temp

- PH level of boiler water
- Smoke spot reading
- For condensing boilers, include corresponding return water temp

5.3102.1k Location of circulator

- Circulator will be installed in very close proximity of the expansion tank such that it is pumping away from the expansion tank

5.3102.1l Air separator

- Air eliminator, microbubble or standard type, will be installed in accordance with manufacturer specifications
- Insulate air and dirt separator

5.3102.1m Bladder expansion tank

- Bladder expansion tanks will be installed in accordance with manufacturer's installation instructions
- When replacing a non-bladder type expansion tank with another non-bladder type, no air elimination equipment will be installed that releases air into atmosphere; only an air elimination device that releases air into the tank will be installed
- Makeup water feed will be installed to the expansion tank connection
- The expansion tank shall be pre-charged, at minimum, to building static pressure before it is connected to the system

5.3102.1n Building manager education

- Completed work will be reviewed with the building management and operations staff
- Copies of manuals for boiler and all other installed system components will be given to maintenance staff
- Building management and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item

5.3102.2 Venting Sealed Combustion Appliances

5.3102.2a Flue vent material selection

- Flue vent material will be selected to prevent flue gas freezing and/or corrosion (double wall where necessary) in accordance with the appliance manufacturer's requirements

5.3102.2b Location of vent termination

- Termination will be located away from windows, doors, walkways, or any air intake opening in accordance with applicable codes and manufacturer's instructions
- Aesthetics and noise should be considered

5.3102.2c Location of venting path

- Venting will be routed in the shortest and most direct path possible in accordance with applicable codes and manufacturer's instructions

5.3102.2d Connection points/joints

- Vent joints will be airtight and watertight in accordance with applicable codes and manufacturer's instructions

5.3102.2e Pitch of flue connection

- Vent will be pitched back to the boiler for categories I, II, and III

- Vent for category IV will be pitched in accordance with manufacturer specifications

5.3102.3 Boiler—Pressure and Temperature Relief Valve (TPV)—Hot Water Boilers

5.3102.3a Check for presence of asbestos-containing materials (ACMs)

- Potential ACMs will be handled in accordance with Potential Asbestos-Containing Materials and Appendix E Health and Safety Requirements, Asbestos Policy

5.3102.3b Assessment of boiler TPV

- Available plans will be reviewed to assess system design and intent (e.g., total relief capacity in water volume and the pressure rating of the valve required for code compliance)

5.3102.3c Install valves

- Pressure and temperature relief valves will be installed in accordance with manufacturer specifications and local codes

5.3102.3d Discharge tube

- Discharge tube will be in place, intact, and installed as sized
- Discharge tube will be the same size as pressure relief valve outlet
- Discharge tube will be properly secured to prevent damage
- Discharge tube termination will be in accordance with local code and manufacturer's requirements

5.3102.3e Verification of TPV installation

- Visually confirm that the pressure temperature valve is rated per manufacturer's recommendation or per local code

5.3102.3f Building manager education

- Completed work will be reviewed with the building management and operations staff
- Building management and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item

5.3102.4 Hot Water Operating Controls—Aquastat (Hot Water)

5.3102.4a Assessment of hot water operating controls

- Controls specified for replacement will be confirmed
- Existing controls to be retained will be confirmed as installed correctly
- Current settings will be documented

5.3102.4b Repair

- Existing installation will be corrected if settings do not match specified scope of work

5.3102.4c Replacement of aquastat

- Existing controls will be removed
- New control will be visible and installed in an accessible location for adjustments in accordance with manufacturer specifications
- New control will be set to temperature settings stated on scope of work

5.3102.4d Testing of system

- Temperature and pressure gauges will be checked for accuracy
- Contractor will observe and confirm boiler operation over a minimum of three cycles

- Safety control will be tested to ensure the burner shuts off at high limit

5.3102.4e Building manager education

- If repair or replacement is completed, building manager will be educated on the operation and purpose of controls and settings

5.3102.14 Expansion Tank Installation (Hot Water)

5.3102.14a Check for presence of asbestos-containing materials (ACMs)

- Potential ACMs will be handled in accordance with Potential Asbestos-Containing Materials and Appendix E Health and Safety Requirements, Asbestos Policy

5.3102.14b Sizing of expansion tank

- Location of expansion tank and operational characteristics (system volume, operating temperature range, operating pressure range, and fluid type) will be used to determine size of tank

5.3102.14c Isolate installation location

- Nearest valves on either side of installation location will be closed

5.3102.14d Install tank

- Tank will be connected to existing system piping in accordance with manufacturer specifications

5.3102.14e Pressurize tank

- Expansion tank will be pressurized in accordance with manufacturer specifications to the appropriate system operating pressure
- System will be filled and air will be eliminated

5.3102.14f Reinsulate area

- Where insulation was removed, new piping will be installed to IECC and ASHRAE 90.1, at a minimum

5.3102.14g Building manager education

- Completed work will be reviewed with the building management and operations staff
- Building management and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item

5.3102.15 Bladder-Type Expansion Tank Pressurization (Hot Water)

5.3102.15a Check for presence of asbestos-containing materials (ACMs)

- Potential ACMs will be handled in accordance with Potential Asbestos-Containing Materials and Appendix E Health and Safety Requirements, Asbestos Policy

5.3102.15b Isolate expansion tank

- Expansion tank valve will be closed
- Existing water will be drained from expansion tank

5.3102.15c Repressurize tank

- Expansion tank will be repressurized in accordance with manufacturer specification to appropriate system operating pressure
- Expansion tank bladder will be replaced in accordance with manufacturer specifications or entire tank will be replaced if unable to maintain required air pressure

- System will be refilled and air will be eliminated

5.3102.15d Building manager education

- Completed work will be reviewed with the building management and operations staff
- Building management and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item

5.3102.19 Replacement of Steam Boiler

5.3102.19a Assessment of a steam boiler

- Confirmation of the scope of work will be made for the following:
  - Clearances
  - Proper drainage in boiler room
  - Flue/chimney conditions
  - Electrical capacity
  - Oil/gas availability
  - Piping connections

5.3102.19b Boiler size calculation

- For one-pipe steam system, radiation survey will be completed, and appropriate piping and pickup factor (e.g., insulation, water volume, return line configuration) will be incorporated
- For two-pipe steam system:
  - Heat load calculations will be confirmed based on ACCA Manual J (for residential applications) and ASHRAE Standard 183 (for high rise application)
  - Radiation survey will be completed, and appropriate piping and pickup factor (e.g., insulation, water volume, return line configuration) will be incorporated
- Sizing will be confirmed for combined space heating and domestic hot water plant

5.3102.19c Removal of condensate tank

- The selection of the boiler will be influenced/dictated as to whether the condensate tank could be eliminated from the system
- Selection will be based on:
  - Elevation of normal operating water level
  - Placement of the low water cutoffs
  - Elevation of lowest horizontal steam piping
  - Usable water volume of boiler

5.3102.19d Mass selection

- Systems will be selected with higher mass heat exchangers
- A higher water volume boiler will be selected to ensure elimination of condensate return tanks

5.3102.19e Multiple boilers/sequencing

- Multiple boiler system controls will be equipped with lead-lag and sequencing capabilities
- Systems will be set up to demonstrate/ensure optimal sequencing

5.3102.19f Fuel switching

- Allowed only when savings-to-investment ratio (SIR) for the fuel switching is ≥1.0

- Chimney will be assessed for proper sizing, lining, and draft

5.3102.19g Hazardous material removal

- Health concerns in the removal and replacement of equipment will be identified
- Written notification of hazardous material will be provided to the property manager/ occupant
- Contact information for the regional EPA asbestos coordinator will be provided
- Asbestos abatement will be conducted by an EPA-certified contractor before decommissioning and replacement
  - Property manager/occupant will be asked to contract with an EPA-certified asbestos contractor to conduct asbestos removal

5.3102.19h Decommissioning

- Accepted industry procedures and practices will be followed to:
  - Remove old boiler and associated components
  - Seal any unused chimneys
  - Remove unused oil tank, piping, valves, and associated equipment

5.3102.19i New equipment installation

- New boiler and associated components will be installed to accepted industry procedures and practices
  - In instances where conflicts occur between the local code and the manufacturer's installation instructions occur, the more restrictive provisions shall apply (IPC 101.3 and UPC 101.2; IPC 301.7 and IPC 101.4)
- Concrete pads will be in accordance with the Uniform Mechanical Code and local building codes
- All required operating and safety controls and boiler trim will be installed and set up in accordance with manufacturer and local code requirements

5.3102.19j Flushing of system

- Isolation valve will be installed at the lowest point and immediately upstream of the Hartford loop
- Flush valve will be located upstream of newly installed isolation valve
- With the isolation valve to boiler closed and flush valve open, system will be run until drain water runs clear

5.3102.19k Startup/skimming of boiler

- In accordance with manufacturer specifications, the new boiler will be flushed and skimmed before steam is released to the building for the first time
- Proper startup will be done in accordance with manufacturer specifications
- Steady state combustion efficiency and safety testing will be performed at multiple firing rates
  - A minimum of two tests, one at high fire and one at low fire, will be performed for low-high-low burner, and a minimum of three tests (low fire, medium fire, and high fire) will be performed for fully modulating burners

5.3102.19l Building manager education

- Completed work will be reviewed with the building management and operations staff
- Building management and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item

5.3102.20 Steam Boiler—Pressure Relief Safety Valve (Certified)

5.3102.20a Check for presence of asbestos-containing materials (ACMs)

- Potential ACMs will be handled in accordance with Potential Asbestos-Containing Materials and Appendix E Health and Safety Requirements, Asbestos Policy

5.3102.20b Assessment of boiler pressure relief valve

- Available plans will be reviewed to assess system design and intent (e.g., total relief capacity in steam volume and number of valves required for code compliance)

5.3102.20c Install valves

- Pressure relief valves will be installed in accordance with manufacturer specifications and in compliance with local codes

5.3102.20d Discharge tube

- Discharge tube will be in place, intact, and installed as sized
- Discharge tube will be the same size as pressure relief valve outlet
- Discharge tube will be properly secured to prevent damage
- Discharge tube termination will be in accordance with applicable codes

5.3102.20e Verification of boiler pressure relief safety valve

- Visually confirm the pressure temperature valve is rated per manufacturer's recommendation or per local code

5.3102.20f Building manager education

- Completed work will be reviewed with the property manager
- Property manager will be educated on the safe and efficient operation and maintenance requirements of the installed item

5.3102.21 Steam Boiler Pressure Operating Controls

5.3102.21a Assessment of steam boiler operating controls

- Controls specified for replacement will be confirmed
- Correct installation of remaining existing controls will be confirmed
- Current settings will be documented

5.3102.21b Repairs

- Existing installation will be corrected if:
  - Pressure control is mercury type, then the anti-siphon piping will be installed perpendicular to the control so that the pressure control stays level
  - Settings do not match specified scope of work

5.3102.21c Replacement of pressure control

- Existing controls will be removed
- All new pressure controls will be free of mercury
- New control will be installed above the boiler water line in accordance with manufacturer specifications
- New control will be set to pressure settings stated on scope of work

5.3102.21d Disposal of mercury-containing pressure control

- Removed mercury-containing pressure control will be disposed of in accordance with EPA guidelines

5.3102.21e Testing of pressure control

- Pressure gauges will be checked for accuracy
- Contractor will observe and confirm boiler operation over a minimum of three cycles
- Safety control will be tested to ensure the burner shuts off at high limit

5.3102.21f Building manager education

- Property manager will be educated on the operation and purpose of controls and settings

5.3102.28 Boiler Burners

5.3102.28a Assessment of boiler burners

- Pre-inspections will be made based on ANSI/ACCA 4 Maintenance of Residential HVAC Systems for residential applications
- Examples of items to be addressed are:
  - Site conditions, verification of efficiency performance, and condition of burner shall be evaluated
  - Safety issues will be addressed

5.3102.28b Service, upgrade, or replace burner

- Inspections will be made based on ANSI/ACCA 4 Maintenance of Residential HVAC Systems for residential applications
- Examples of items to be addressed are as follows:
  - Combustion air intake dampers
  - Fuel/air modulating
  - Electronic ignition
  - Linkage-less fuel/air control
  - Oxygen trim
  - Variable frequency drives
  - Low nitrogen oxide (replacement burner)
  - High turndown ratio burner

5.3102.28c Combustion efficiency

- Undiluted flue gases will be checked with a calibrated flue gas analyzer in accordance with accepted protocol
- If combustion is not occurring safely or with maximum efficiency, diagnostics and adjustments will be done in accordance with work order specifications
- Fuel/air ratio will be adjusted to meet specified performance over a range of firing rates, when applicable

5.3102.28d Modulation

- Contractor will demonstrate the burner modulates over the specified operating range (steam pressure and water temperature) and firing rates
- Combustion efficiency will match work order specifications over specified firing rates or turndown ratios

5.3102.28e Building manager education

- Operations staff will be educated on burner capabilities and ongoing maintenance

5.3102.28f Startup of the steam boiler

- Startup will be performed by licensed professional or "qualified person" as defined in NFPA 31, 3.3.50

5.3102.28g Steam Boiler Fueling Options

- Where applicable, dual fuel systems will be recommended when replacing oil-fired burners
- Dual fuel switch control operation will be confirmed

5.3102.31 Installation of Boiler Thermometers (Includes Hot Water)

5.3102.31a Check for presence of asbestos-containing materials (ACMs)

- Potential ACMs will be handled in accordance with Potential Asbestos-Containing Materials and Appendix E Health and Safety Requirements, Asbestos Policy

5.3102.31b Determine locations for thermometers

- Available plans will be reviewed to assess system design and intent
- Thermometer locations and conditions will be visually verified; thermometers will be located on the inlet and outlet of all heat transfer devices (e.g., boilers, heat exchangers, and coils) and the supply and return to all distribution loops

5.3102.31c Select appropriate thermometer (thermowell vs. strap-on)

- Thermometer selection will be provided for accurate measurement with rapid response to temperature change
- Strap-on thermometers will be an option for copper piping applications
- Thermowell thermometers will be used in applications where piping diameter is 4" or larger

5.3102.31d Install thermowell thermometer, when necessary

- Nearest valves on either side of thermowell location will be closed
- Thermowell will be installed and extend midway into fluid flow
- Thermowell thermometers will be installed with heat transfer grease between sensing element and thermowell
- System will be refilled and air will be eliminated

5.3102.31e Install strap-on thermometer (preferred)

- Strap-on thermometers will be attached tightly with heat transfer grease applied between sensing element and pipe
- Thermometers will be installed facing so that minimum effort is required to read it

5.3102.31f Reinsulate boiler

- Where insulation was removed, sensing element and associated piping will be reinsulated with new insulation in accordance with IECC (International Energy Conservation Code) and ASHRAE 90.1, at a minimum

5.3102.31g Building manager education

- Completed work will be reviewed with the building management and operations staff
- Building management and operations staff will be educated on the safe and efficient operation and maintenance requirements of the installed item

5.3102.37 Boiler Controls—Thermostat Replacement

5.3102.37a Visual inspection of controls

- Thermostats will be visually located
- Replacement will be recommended if a digital, programmable thermostat is not present
  - Note: High-mass radiant systems may or may not benefit from programmable thermostats

5.3102.37b Mercury assessment

- Thermostats containing mercury will be identified and disposed of in accordance with EPA guidance

5.3102.37c Installation of boiler controls

- Location for new thermostat will be determined in accordance with applicable codes and manufacturer's instructions
- The new thermostat will be located such that it is easily accessible for control without any need for step stool or ladder to comply with Federal Fair Housing Act
- Compatibility of the existing system with new thermostat will be verified (e.g., voltage, wiring, condition, location)
- New thermostat will be installed

5.3102.37d Testing of boiler controls

- Heating system will be re-energized and cycled
- Thermostat will be programmed to occupant's lifestyle choices

5.3102.37e Disposal

- Removed thermostats will be disposed of in accordance with EPA guidelines

5.3102.37f Building manager education

- Building management and operations staff and occupants will be involved in the initial programming of thermostat and educated on common settings and programming
- On new installs, building management and operations staff and occupants will be encouraged to save the manual and keep it accessible

5.3104 Hydronic Heating Equipment Maintenance, Testing, and Repair

5.3104.9 Hydronic Heating (Hot Water, Steam)—Pre-Inspection Checklist

5.3104.9a Check for presence of asbestos-containing materials (ACMs)

- Potential ACMs will be handled in accordance with Potential Asbestos-Containing Materials and Appendix E Health and Safety Requirements, Asbestos Policy

5.3104.9b Health and safety

- Boiler room makeup air openings shall be in compliance with original equipment manufacturer (OEM) requirements and NFPA 54 and NFPA 31

5.3104.9c Visual inspection

- The following conditions will be inspected:
  - Water, steam, and fuel leaks
  - Damaged or missing pipe insulation

- Draft and condensation venting issues (e.g., soot, rusting of flue pipe, burned paint or wires, efflorescence)
- Corrosion (e.g., rust, mineral deposits)
- General condition of components
- Controls and control settings

5.3104.9d Pipe, tank, and boiler insulation inspection

- Pipe, tank, and boiler insulation will be inspected, including:
  - Integrity—complete coverage, no holes or tears
  - Damage—holes or tears
  - Complete coverage—insulation missing
- If asbestos is suspected, occupants will be notified, and asbestos will not be disturbed
- Required repair or replacement will be performed in accordance with the following conditions:
  - Materials will be approved for steam heating pipes
  - Materials will be approved for hot water heating pipes
  - Insulation will completely cover pipe
- Pipe, tank, and boiler insulation will be installed in accordance with manufacturer specifications

5.3104.9e System static pressure

- For hot water systems, static pressure will be verified

5.3104.9f Purge system

- Each accessible heat emitter will be purged

5.3104.9g Automatic fill for hot water boilers

- Automatic fill valve will be inspected to ensure it maintains system pressure
- If pressure is not maintained, replacement will be made in accordance with the following criteria:
  - A backflow preventer will be installed upstream of automatic fill valve if one is not existing
  - Automatic fill valve and components will be installed in accordance with manufacturer specifications
  - Correct system pressure will be verified

5.3104.9h Gauge glass: steam boiler

- Gauge glass will be inspected for erosion, cracks, or drying
- Damaged gauge glass on boiler will be replaced in accordance with manufacturer specifications
- Gauge glass that is coated with dirt or sediment, making it difficult to observe the water level of the boiler, will be removed, cleaned, and replaced

5.3104.9i Low water cutoff: float type

- Operation of low water cutoff will be observed by opening blow-off valve
- If combustion is not extinguished, remediation will be accomplished by the following procedure:
  - Electricity will be disconnected from boiler
  - Problem will be diagnosed

  - Low water cutoff will be repaired, serviced, or replaced in accordance with manufacturer specifications
  - A blow-down valve will be added if not already present
  - Boiler will be retested for proper operation
- Building management and operations staff will be educated on the correct method to drain the low water cutoff weekly (must drain once per week to remove sediment from float chamber of low water cutoff)

5.3104.9j Low water cutoff: probe type

- A probe type low water cutoff will be installed and operable
- Low water cutoff with manual reset switch will be installed in accordance with local code requirements

5.3104.9k Expansion tank: non-bladder and bladder

- An expansion tank will be installed and operable
- Tanks that leak or have excessive corrosion will be replaced and non-bladder tanks will include an expansion tank drain
- Tank will be installed in accordance with manufacturer specifications
- Expansion tanks will be properly supported with strapping
- Tanks that are full of water will be drained and refilled before being replaced or repaired
- Expansion tanks with bladders will be pre-charged, minimum to system static pressure, while water is not present in the tank
- Bladder tanks that have water inside of the air bladder will be replaced in accordance with manufacturer specifications

5.3104.9l Flush or skim steam boiler

- Flushing or skimming steam boiler will be in accordance with manufacturer specifications
- Blow down after cooler shall be tested

5.3104.9m System temperature or pressure gauge

- The temperature or pressure gauge will be inspected for erosion, cracks or dirt
- Damaged temperature or pressure gauges will be replaced in accordance with manufacturer specifications

5.3104.9n Circulating pumps

- Nonworking motors that cannot be serviced will be replaced with a new, premium efficiency motor
- New motors will be installed in accordance with manufacturer specifications
- Oil-lubricated circulating pumps will be installed in proper alignment with the pump coupler and will be supported so they do not sag
- Bearings will have free movement and no water leakage
- New circulator will be installed when needed

5.3104.9o Zone valves

- Zone valves will be inspected for the following conditions:
  - Leaking water
  - Not responding to a call for heat
  - New equipment will be replaced in accordance with manufacturer specifications

5.3104.9p Flue gas condensate

- If boiler is 90% efficient or greater, a neutralization kit will be installed to neutralize flue gas condensate before discharging it in accordance with local code requirements
- Condensate pumps will be installed if needed to ensure proper drainage
- Condensate neutralization kit shall be installed in such a way that the remaining neutralizing agent level is easily viewed and replaced

5.3104.9q Air vents: steam systems

- Occupant will be informed that air vents have potential to cause moisture problems if not operating properly
- Occupant will be reminded to call for maintenance if vents discharge steam or have moisture issues

5.3104.9r Maintenance records

- Keeping records of all maintenance will be recommended to the building manager
- Copies or access to installation and operation manuals will be provided

5.3104.9s Occupant health and safety

- When a hydronic heating system will be replaced, all homes will have a functioning CO alarm
  - If determined to be more than 5 years old, CO detector/alarm will be replaced
  - If CO levels in interior living spaces exceed outdoor levels, potential sources will be investigated and appropriate action taken to reduce them (e.g., have a qualified professional tune, repair, or replace improperly operating combustion appliances; apply weatherstripping or conduct air sealing between the garage or crawlspace and the home)

5.3104.9t Building manager education

- Completed work will be reviewed
- Occupants will be educated on the safe and efficient operation and maintenance of the system

5.3300 Non-Ducted Cooling Systems

5.3302 Room Air Conditioners

5.3302.1 Wall and Window (Room) Air Conditioning Unit Replacement

5.3302.1a Assessment for wall/window air conditioners

- Physical size of through-wall opening will be determined
- Unit and electrical receptacle will meet requirements of NFPA 70 Article 440
- Work order will be evaluated against site circumstances

5.3302.1b Selection of wall/window air conditioner units

- Unit will match available voltage and not exceed current available voltage at the existing electrical outlet
- Replacement unit will provide same or better functionality than existing unit, but smaller duty unit will be provided if existing is oversized
- Replacement unit will be ENERGY STAR®–qualified with Energy Saver Mode or better

- Units with R22 refrigerant will not be used

5.3302.1c Installation of units

- Extension cords will not be used (in accordance with the NFPA 70 Article 440 standard)
- Where applicable unit controls and thermostat shall comply with the operable parts provisions of ICC A117.1 when the dwelling unit is required to be accessible per ADA
- Unit will be self-supporting or permanently installed
- Perimeter of unit will be sealed with a durable material (ASTM C1193)
- Egress will be addressed to be in accordance with ANSI/NFPA 101 and local laws

5.3302.1d Decommissioning

- Units replaced will be recycled or disposed of in accordance with local ordinances
- Refrigerant will be handled in accordance with Section 608 of Clean Air Act of 1990 and local ordinances

5.3302.1e Building manager education

- Building operations staff will be educated on strategies for winterizing cooling-only equipment, such as removal and storage of window units during long periods of cold and snow
- When unit is not in use, it will be closed and covered in accordance with Wall Penetration Sealing
- Building operations staff will be provided with warranty information, operation manuals, and installer contact information

5.3302.1f Occupant education

- Occupants will be provided with a manual and educated about new unit benefits
  - Education will be provided by building operations staff

6. VENTILATION

6.6000 Exhaust Ventilation Fans

Where identified below for kitchen ventilation and/or mechanical ventilation, the Multi-Family Weatherization TRM shall apply. If certain policies for these measures are not addressed, Section 11 Kitchen Exhaust or Section 12 Mechanical Ventilation shall apply.

6.6004 Exhaust Ventilation Systems

6.6004.1 Central/Common Exhaust Fan Serving Multiple Dwelling Units via Common Duct(s) and Dwelling Unit Branches

6.6004.1a Pre-inspection

- Specifications will be field verified as appropriate to site conditions by installer

6.6004.1b Fan airflow

- ASHRAE 62.2 and local code requirements should be followed for identifying design airflow rates within apartment dwelling units
- All other areas will follow local code requirements and/or ASHRAE 62.1 requirements
- Airflows will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements

6.6004.1c Fan specification

- Motors of 1 horsepower (HP) or larger will be rated "Premium Efficiency" by NEMA
- Fan will be capable of maintaining a minimum operating static pressure of 0.25 inches of water column (IWC) or the pressure that is required by the system design to ensure proper operation of all system components
- Motors less than 1 HP, used for continuous whole-building ventilation, will be rated by the Home Ventilation Institute to provide at least the required ventilation rate at a minimum operating static pressure of 0.25 IWC or the pressure that is required by the system design to ensure proper operation of all system components

6.6004.1d Fan outlet termination

- Outlet will be terminated outside of the building shell and will have a louvered cover and ¼" screen
- Minimum distance of exhaust outlet from any doors, windows, or outside air intakes shall conform with the applicable building code
- Outlet will be sealed to prevent water intrusion

6.6004.1e Wiring

- Wiring will be installed by a licensed contractor
- Wiring will be installed in accordance with original equipment manufacturer specifications and local and national electrical (NFPA 70) and mechanical codes

6.6004.1f Access

- Installed fan and service switch shall be accessible for maintenance

6.6004.1g Outdoor/indoor fan mounting

- Fan will be oriented so the equivalent length of the duct run is as short as possible

- Fan will be mounted securely in accordance with manufacturer specifications and local code requirements (in terms of seismic restraints, vibration, and noise control)
- Fan will be isolated from the building framing unless specifically designed to be directly attached

6.6004.1h Connecting exposed ductwork

- All exposed ductwork outside of the building will be insulated to a minimum R-8, protected from weather exposure, and sealed at all penetrations into building shell

6.6004.1i Fan/duct riser connection

- If fan is on curb, the riser will be flashed to the top of the curb and the fan will be sealed to the riser flashing
- If the fan is separate from the curb, the riser will be flashed to the top of the curb
- Duct connector will be sealed to the top of the riser flashing
- Ductwork will be attached via a flexible connection and will maintain the intended fan opening

6.6004.1j Backdraft dampers

- A backdraft damper will be installed at or near the fan
- A backdraft damper will be installed at each dwelling unit unless the fan is a whole-building fan and runs on a continuous operating system

6.6004.1k Combining intake ducts

- All individual intake ducts will be combined on the inlet side of fan (e.g., Y-fitting, T-fitting, collector box)

6.6004.1l Duct connections

- All riser ducts or plenums will be connected and sealed to applicable intakes, collector box, fan, and termination fitting
- Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers
- Ducts will be connected and sealed in accordance with the applicable code adopted by the jurisdiction

6.6004.1m Component insulation

- All components outside of the thermal envelope will be insulated to a minimum of R-8 or as required by local codes
- Insulation shall be exterior-rated

6.6004.1n Register boot to interior surface seal

- Register boot will be sealed to interior surfaces with sealants compatible to their intended surfaces
- Sealants will be continuous and meet fire barrier specifications

6.6004.1o Preventing air leakage caused by exhaust fans

- Walls, ceilings, and floors will be sealed to separate any occupied space from any unconditioned spaces and adjacent dwelling units
- Refer to ASHRAE 62.2 Addendum J

6.6004.1p Balance and airflow

- Airflow will be measured and adjusted to match the design specification in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111

6.6004.1q Combustion zone testing

- Open combustion appliance backdrafting caused by exhaust fans will be assessed and corrected

6.6004.1r Fire dampers

- Fire dampers must be accessible for inspection and/or testing by the local authorities; if fire dampers are not accessible from a grille or register, an access door in the ductwork is required
- Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers
- Type B fire dampers will be used as required by fire code

6.6004.1s Occupant/building manager education

- Occupant/building manager will be educated on purpose and value of system
- Building manager will be instructed on all maintenance procedures

6.6004.2 Individual Unit Exhaust Fan Serving Multiple Rooms

6.6004.2a Pre-inspection

- Specifications will be field verified as appropriate to site conditions by installer

6.6004.2b Fan airflow

- ASHRAE 62.2 and local code requirements should be followed for identifying design airflow rates within apartment dwelling units
- All other areas will follow local code requirements and/or ASHRAE 62.1 requirements
- Airflows will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements

6.6004.2c Outlet termination

- Outlet will be terminated outside of the building shell and will have a louvered cover and bird screen
- Minimum distance of exhaust outlet from any doors, windows, or outside air intakes shall be in conformance with the applicable building code
- Outlet will be sealed to prevent water intrusion and exhaust air leakage into building cavities

6.6004.2d Wiring

- Wiring will be installed by a properly licensed contractor
- Wiring will be installed in accordance with original equipment manufacturer specifications and local and national (NFPA 70) electrical and mechanical codes

6.6004.2e Access

- Fan and service switch will be accessible for maintenance

6.6004.2f Fan mounting

- Fan will be oriented so the equivalent length of the duct run is as short as possible
- Fan will be mounted securely in accordance with manufacturer specifications and local code requirements (in terms of seismic restraints, vibration, and noise control)

6.6004.2g Backdraft dampers (required in intermittent systems)

- A backdraft damper will be installed between the fan and the exterior

- A backdraft damper will be installed in any duct serving any room with a separate exhaust (e.g., dryer)

6.6004.2h Combining intake ducts

- All individual intake ducts will be combined on the intake side of fan (e.g., Y-fitting, T-fitting, collector box)

6.6004.2i Duct connections

- Ducts will be connected and sealed to applicable intakes, collector box, fan, and termination fitting
- Ducts will be connected and sealed in accordance with the applicable code adopted by the jurisdiction

6.6004.2j Component insulation

- All components outside of the thermal envelope will be insulated to a minimum of R-8 or as required by local codes
- Insulation shall be exterior-rated

6.6004.2k Boot to interior surface seal

- Register boot will be sealed to interior surfaces with sealants compatible to their intended surfaces
- Sealants will be continuous and meet fire barrier specifications
- Boots will be connected and sealed in accordance with the applicable code adopted by the jurisdiction

6.6004.2l Preventing air leakage caused by exhaust fans

- Walls, ceilings, and floors will be sealed to separate any occupied space from any unconditioned spaces and adjacent dwelling units
- Refer to ASHRAE 62.2 Section 6.1

6.6004.2m Balance and airflow

- Airflows will be measured and adjusted to match to the design specification

6.6004.2n Combustion zone testing

- Open combustion appliance backdrafting caused by exhaust fans will be assessed and corrected

6.6004.2o Fire dampers

- Fire dampers must be accessible for inspection and/or testing by the local authorities; if fire dampers are not accessible from a grille or register, an access door in the ductwork is required
- Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers
- Type B fire dampers will be used as required by fire code

6.6004.2p Occupant/building manager education

- Occupant/building manager will be educated about purpose and value of system
- Building manager will be instructed about all maintenance procedures

6.6005 Local Exhaust Ventilation Fans

6.6005.4 Kitchen Range Hood within Dwelling Unit

6.6005.4a Pre-inspection

- Specifications will be field verified as appropriate to site conditions by installer

6.6005.4b Wiring

- Wiring will be installed by a properly licensed contractor when required by the local jurisdiction
- Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national (NFPA 70) electrical and mechanical codes

6.6005.4c Fan selection

- Fans installed in range hoods over cooking appliances will be designed per Home Ventilation Institute (HVI) 2100 specifications
- Airflow rate will be a minimum of 100 cubic feet per minute (CFM)

6.6005.4d Fan venting

- Kitchen range fans will be vented directly to the outside
- Recirculating fans will not be used as a kitchen exhaust ventilating device

6.6005.4e Fan ducting

- Kitchen range fans will be ducted directly to the outdoors
- As short a run as practical of smooth wall metal duct will be used, following manufacturer specifications and IMC 2009 505
- Ducting will be connected and sealed as described in Central/Common Exhaust Fan Serving Multiple Dwelling Units via Common Duct(s) and Dwelling Unit Branches and Individual Unit Exhaust Fan Serving Multiple Rooms

6.6005.4f Termination fitting

- Termination fitting will be installed, including a backdraft damper, as described in termination fitting detail
- Outlet will be terminated outside of the building shell and will have a louvered cover and ¼" screen
- Minimum distance of exhaust outlets installed new from any doors or operable windows or outside air intakes will meet local code requirements or specifications of ASHRAE 62.1, Table 5-1 requirements
- Outlet will be sealed to prevent water and air intrusion

6.6005.4g Makeup air

- Makeup air will be provided for kitchen range fans exhausting more than 400 CFM

6.6005.4h Fan airflow verification

- Exhaust flow rates will be measured and documented to meet design requirements

6.6005.4i Combustion zone testing

- Open combustion appliance backdrafting caused by exhaust fans will be assessed and corrected

6.6005.4j Occupant/building manager education

- Occupant/building manager will be instructed to keep grease filters and termination fitting clean

6.6088 Special Considerations in Selecting Ventilation Fans

6.6088.1 Regional Climatic Considerations

The climate where the multi-family building is located shall be considered when selecting ventilation fans.

6.6088.1a Very cold climates

- Ventilation terminations will have backflow dampers that resist freezing

6.6088.1b Cold climates

- Exhaust ventilation will be terminated at the roof, gable end, or wall

6.6088.1c Mixed or humid climates

- Ventilation ducts will be insulated to R-8 or greater
- Ventilation exhaust ducts will be terminated on the exterior of the building
- Ventilation exhausts terminating through a soffit will direct exhaust air away from the soffit vents

6.6100 Supply Ventilation Fans

6.6102 Components

6.6102.5 Supply Fan Register Locations

6.6102.5a Primary whole building

- Supply register will be installed in high occupancy rooms or rooms used for sleeping

6.6102.5b Local exhaust fan (kitchen exhaust) makeup air

- A makeup air path and makeup air (passive ventilation or supply ventilation source) will be provided for exhaust devices that exceed 200 cubic feet per minute (CMF) of airflow

6.6102.6 Supply Fan Intakes

6.6102.6a Hole in building shell

- Holes cut to accommodate the terminal fittings should be no more than ⅛" larger than the fitting itself

6.6102.6b Intake fitting

- Intake fitting will have integrated collar at least the same diameter as the duct
- The fitting will be appropriate for regional weather conditions and installation location on exterior of building

6.6102.6c Occupant/building manager education

- Intake fitting will be labeled "ventilation air intake"
- Occupant/building manager will be instructed to keep yard debris and other contaminants clear of the intake

6.6102.6d Damper (if applicable)

- The damper will be installed to open in the direction of the desired flow
- Damper will close when system is off

6.6102.6e Connection to intake fitting

- Duct to intake fitting will be connected and sealed in accordance with supply duct detail
- Ensure fasteners do not inhibit intake damper operation

6.6102.6f Weatherproofing

- Exterior termination fitting will be flashed or weather sealed
- Water will be directed away from penetration
- Installation will not inhibit damper operation
- Weatherproofing will be in accordance with manufacturer specifications

6.6102.6g Pest exclusion

- Screen material no less than ¼" and no greater than ½" hole size in any direction will be used
- Screen will be installed so it does not inhibit intake damper operation

6.6102.6h Intake location

- Intake will be installed in accordance with all applicable code requirements and/or the latest CSD-adopted version of ASHRAE 62.2

6.6102.7 Ducts for Supply Fans

6.6102.7a Duct design and configuration

- Duct shall be designed in accordance with the applicable codes adopted by the jurisdiction

6.6102.7b Duct insulation

- Ducts installed outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes

6.6102.7c Duct supports

- Ducts will be supported as required by the applicable code adopted by the jurisdiction for the type of duct used

6.6102.7d Duct connections

- Metal-to-metal or metal-to-PVC connections will be fastened with a minimum of three equally spaced screws
- Flexible duct-to-metal or flexible duct-to-PVC connections will be fastened with tie bands using a and be tightened with a tensioning tool
- Flexible duct between the cable tie and end of metal or PVC duct will be mechanically attached with at least three equally-spaced screws
- PVC-to-PVC materials will be fastened with approved PVC cement
- Supply ducts attached to the return side of forced air systems will be:
  - Attached as close to the HVAC system's fan as possible while remaining in compliance with manufacturer specifications
  - Set up to provide filtration of outdoor ventilation air before reaching the HVAC system
  - Attached via a mechanically fastened take-off collar
- In addition to mechanical fasteners, air seal duct connections will be fastened with UL 181B or 181B-M listed material

- All other duct connections shall be in conformance with the applicable code adopted by the jurisdiction

6.6102.7e Duct materials

- Flexible duct materials will be UL 181 listed or Air Diffusion Council approved

6.6102.7f Outdoor air intake location

- Intake will be installed in accordance with all applicable code requirements and/or the latest CSD-adopted version of ASHRAE 62.2

6.6104 Supply Ventilation System

6.6104.1 Outdoor Supply Air Handling Unit Serving Multiple Dwelling Units

6.6104.1a Pre-inspection

- Specifications will be field verified as appropriate to site conditions by installer

6.6104.1b Supply airflow

- ASHRAE 62.2 and local code requirements should be followed for identifying design airflow rates within apartment dwelling units
- All other areas will follow local code requirements and/or ASHRAE 62.1 requirements
- Airflows will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements

6.6104.1c Fan specification

- Motors 1 horsepower or larger will meet NEMA premium efficiency standards
- Fan will be capable of maintaining a minimum operating static pressure of 0.25 IWC

6.6104.1d Intake location

- Intake will be installed in accordance with all applicable code requirements and/or the latest CSD-adopted version of ASHRAE 62.2

6.6104.1e Intake fitting

- Intake fitting will have an integrated collar at least the same diameter as the duct
- Fitting will be appropriate for regional weather conditions and installation location on exterior of building

6.6104.1f Weatherproofing

- Exterior termination fitting will be flashed or weather sealed
- Water will be directed away from penetration
- Weatherproofing will be in accordance with manufacturer specifications

6.6104.1g Pest exclusion

- Screen material no less than ¼" and no greater than ½" hole size in any direction will be used

6.6104.1h Damper (if applicable)

- Damper will close when system is off
- Damper will be installed to open in the direction of the desired flow

6.6104.1i Wiring

- Wiring will be installed by a licensed contractor
- Wiring will be installed in accordance with original equipment manufacturer (OEM) specifications, and local and national electrical (NFPA 70) and mechanical codes

6.6104.1j Access

- Fan, service switch, filter, and conditioning coils will be accessible for cleaning, maintenance, and repair

6.6104.1k Outdoor/fresh air makeup air handling unit mounting

- Air handling unit outlet will be oriented toward the final termination location
- Air handling unit will be oriented so the equivalent length of the duct run is as short as possible
- Air handling unit will be mounted securely in accordance with manufacturer specifications and local code requirements (in terms of seismic restraints)
- Air handling unit will be isolated from the building framing unless specifically designed to be directly attached

6.6104.1l Air handling unit/duct riser connection

- Duct will be sealed to the top of the curb (for roof-mounted systems)
- Ductwork will be attached via a flexible connection, and will be installed in accordance with OEM and duct design minimum sizing requirements

6.6104.1m Duct connections

- All ducts, including intake fitting, will be connected and sealed in accordance with supply duct sealing

6.6104.1n Insulation of fan components

- All components outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes
- All exposed ductwork outside of the building will be insulated to a minimum R-12, protected from weather exposure, and sealed at all penetrations into the building shell

6.6104.1o Register boot to interior surface seal

- Register boot will be sealed to interior surfaces with sealants compatible to their intended surfaces
- Sealants will be continuous and meet fire barrier specifications

6.6104.1p Preventing air leakage caused by air pressure differences between spaces

- Walls, ceilings, and floors will be sealed to separate any occupied space from any unconditioned spaces and adjacent dwelling units
- Refer to ASHRAE 62.2 Addendum J
- If system design calls for supply air to enter dwelling units from pressurized corridor to under the door, then door will not be weatherstripped

6.6104.1q Balance and airflow

- Airflows will be measured and adjusted in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and documented to meet design requirements

6.6104.1r Fire dampers

- Fire dampers must be accessible for inspection and/or testing by the local authorities
  - If fire dampers are not accessible from a grille or register, an access door in the ductwork is required
- Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers
- Type B fire dampers will be used as required by fire code

6.6104.1s Occupant/building manager education

- Intake fitting will be labeled "ventilation air intake"
- Occupant/building manager will be instructed on purpose and value of system, and instructed to keep underside of door unobstructed (in pressurized corridor designs)
- Building manager will be instructed on the maintenance and procedures of maintaining system

6.6104.2 Outdoor Intake to Forced Air System—One System per Dwelling

6.6104.2a Forced air system

- Specifications will be field verified as appropriate to site conditions by installer
- Forced air system will be appropriately sized to handle latent and sensible loads of dwelling unit with the addition of conditioned or unconditioned outside ventilation air
- The manufacturer's temperature rise shall be maintained
- Forced air system duct leakage will be less than 10% of the air handler design flow when measured at 25 Pa

6.6104.2b Wiring

- Wiring will be installed by a licensed contractor
- Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical (NFPA 70) and mechanical codes

6.6104.2c Intake location

- Intake will be installed in accordance with all applicable code requirements and/or the latest CSD-adopted version of ASHRAE 62.2

6.6104.2d Mounting intake duct

- Outdoor air ventilation duct will be attached as close to the return side of the HVAC system's circulating fan as possible while remaining in compliance with manufacturer temperature rise specifications
- Filtration of ventilation air will be provided before reaching the HVAC fan
- Duct will be connected to intake fitting
- Connection and seal will be performed in accordance with supply duct detail

6.6104.2e Insulation

- All duct components from outdoor intake to the air handler cabinet will be insulated to minimum level of R-8

6.6104.2f Access

- Motorized damper and service switch will be accessible for maintenance

6.6104.2g Motorized damper

- A motorized damper or equivalent technology will be installed between the outdoor air intake fitting and the return side of the air handler circulating fan
- Outdoor airflow will be provided by scheduled operation of the damper or equivalent technology
- Damper will be open only when the air handler fan is operating

6.6104.2h Verification

- Outdoor air intake flow rates will be measured and documented to meet design requirements
- Proper operation and calibration of controls and damper sequencing will be verified by installer

6.6104.2i Fire dampers

- Fire dampers must be accessible for inspection and/or testing by the local authorities
  - If fire dampers are not accessible from a grille or register, an access door in the ductwork is required
- Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers
- Type B fire dampers will be used as required by fire code

6.6104.2j Occupant/building manager education

- Occupant/building manager will be educated on the purpose of the system and how it works

6.6200 Whole Building Mechanical Ventilation

6.6201 Airflow Requirements

6.6201.3 Primary Ventilation Airflow Between Rooms

6.6201.3a Balancing pressure

- An appropriate means of pressure balancing will be installed (e.g., transfer grilles, jumper ducts, individual room returns)
- No room will exceed +/-3 Pa with reference to the outside with all interior doors closed and ventilation systems running
- Return airflow paths for residential space shall be designed in accordance with ANSI/ACCA 1 Manual D or equivalent
- Ducts for common areas shall be designed in accordance with ASHRAE procedures or ACCA Manual Q

6.6201.4 Balancing—Makeup/Outside Air

6.6201.4a Validate air distribution system installation

- System will be checked for existence of specified system components

6.6201.4b Testing equipment selection

- Measurement equipment will be selected so that design value will be within the accurate range of the measuring device
- Equipment will be capable of accurately measuring +/-10% in general case

- If design flow is less than 100 cubic feet per minute (CFM), equipment will be capable of accurately measuring down to 10 CFM (+/-5%)
- Static pressures will be measured using manometers capable of measuring +/-1 Pascal
- Measurement equipment will be calibrated and field checked in accordance with manufacturer recommendations

6.6201.4c Test main fan or air handler unit

- Equipment testing will check for:
  - Proper operation (programmed schedule/sequence of operation)
  - Proper rotation
  - Filter condition
  - Total flow at fan
- Fan airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111
  - All measured values will be recorded and compared against design specifications
- Fan flow will be adjusted to meet design specification

6.6201.4d Measure airflow and static pressure at terminals

- Airflow and static pressure will be measured and recorded
- Measurements will be taken with terminals as found, with no adjustments made to the grille fins
- All measured values will be recorded and compared against design specifications
- The terminal with the lowest flow will be identified and recorded

6.6201.4e Adjustment of system

- Adjustments will be made to fan speed, dampers, and registers until design specifications are met

6.6201.4f Final balance

- Final airflow and/or pressure will be measured, confirmed, and recorded at fan and terminals

6.6201.4g Occupant/building manager education

- Occupant/building manager will be:
  - Instructed on proper operation and maintenance procedures
  - Educated on value and need for recommissioning requirements

6.6202 Ventilation Components

6.6202.3 Airflow Control Devices

6.6202.3a Pre-inspection

- Specifications will be field verified as appropriate to site conditions by installer (e.g., duct size, type, shape, register type, duct static pressure)
- Access to all dwelling units and elements of distribution system will be ensured by installer

6.6202.3b Preparation

- Register cleaning or replacement will be performed as specified

- Duct sealing will be performed as specified
- Stack pressures will be verified for proper operation of flow control device
- Presence and type of dampers and smoke control devices will be identified, and installer will ensure the installation of the airflow device will not interfere with proper operation

6.6202.3c Material selection

- Appropriate selection of airflow regulator or orifice will be confirmed by installer; if custom design is required, it will be determined by installer
- Registers will be compatible with selected flow control device
- Gasketing or transition system will be compatible with selected flow control device and existing duct components
- Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications
- Duct sealants will be UL 181 compliant
- Sealants and materials will be continuous and in accordance with fire barrier specifications

6.6202.3d Installation

- Transition or adapter will be securely fastened and sealed in accordance with manufacturer specifications
- Flow control device will be installed with proper orientation and in accordance with manufacturer specifications
- Adjustable devices will be set to preliminary balancing position

6.6202.3e Balance and airflow

- Fan airflow will be measured and adjusted to match to the design specification in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111

6.6202.3f Verification of airflow

- Final visual inspection of flow control installation and installer documentation will be completed
- Continued operation of dampers and smoke control devices will be verified

6.6202.3g Occupant/building manager education

- Occupant/building manager will be educated on how the system works and its purpose
- Occupant/building manager will be educated on how to inspect flow control device upon unit turnover

6.6202.4 Operational Controls

6.6202.4a Primary (mechanical) ventilation fans

- Specifications will be field verified as appropriate to site conditions by installer
- Controls will be used that can meet the following conditions:
  - Run fan continuously or intermittently, depending upon the intended schedule of operation
  - Operate fan to produce the intended flow for each intended flow setting
  - Any switch for ventilation system will be labeled

6.6202.4b Local/spot ventilation fans

- Controls will be used that meet the following conditions:
  - Run fan continuously or intermittently, depending on the intended schedule of operation
  - Run fan for intended time for timed operation
  - Operate fan to produce the intended flow for each intended flow setting

6.6202.4c Wiring

- Wiring will be installed by a properly licensed contractor
- Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical (NFPA 70) and mechanical codes

6.6202.4d Occupancy sensors/humidistat

- Manual override will be present on all controls
- Occupancy sensor and/or humidistat will be calibrated and commissioned effectively, and on a maintenance schedule
- Manufacturer specifications will be followed

6.6202.4e Carbon dioxide sensors (demand control)

- Multispeed or variable frequency drive fan will be required
- Sensors will be calibrated and commissioned effectively, and on a maintenance schedule
- Manufacturer specifications will be followed

6.6202.4f Occupant/building manager education

- When fan controls are present and controlled by occupant, a system operation guide designed for occupants (nonprofessionals) will be provided to explain how and why to operate system
- Every six months, maintenance staff will be advised to verify timer systems are in place and are operating properly

6.6202.6 Heat Recovery Ventilator (HRV) and Energy Recovery Ventilator (ERV) Installation in Dwelling Units

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

6.6202.6a Equipment specifications

- Specifications will be field verified as appropriate to site conditions by the installer

6.6202.6b Airflow

- ASHRAE 62.2 and local code requirements should be followed for identifying design airflow rates within apartment dwelling units
- All other areas will follow local code requirements and/or ASHRAE 62.1 requirements
- Fan airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements

6.6202.6c Wiring

- Wiring will be installed by a properly licensed contractor
- Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical (NFPA 70) and mechanical codes

6.6202.6d Access

- Fans, service switch, filters, drain, and drain pan will be accessible for maintenance or replacement

6.6202.6e HRV/ERV mounting

- Fan will be mounted securely in accordance with manufacturer specifications and local code requirements (e.g., seismic restraints)
- Fan will be oriented so the equivalent length of the duct run is as short as possible
- Fan will be isolated from the building framing unless specifically designed to be directly attached

6.6202.6f Condensate drain

- Condensation shall be drained to a location approved by the local jurisdiction

6.6202.6g Backdraft dampers

- A backdraft damper will be installed between the HRV or ERV and the exterior

6.6202.6h Fan outlet termination

- Minimum distance of exhaust outlet from any doors, windows, or outside air intakes shall be in conformance with the applicable building code
- Outlet will be sealed to prevent water intrusion and exhaust air leakage into building cavities

6.6202.6i Intake location

- Intake will be installed in accordance with the following:
  - A minimum of 6" above grade
  - A minimum of 10' from contaminant sources
  - Above local snow or flood line
  - A minimum of 18" above an asphalt-based roof
- Minimum distance between exhaust outlet and air intake will be 6' or in accordance with manufacturer specifications

6.6202.6j Intake/exhaust fitting

- Intake/exhaust fitting will have integrated collar that is at least the same diameter as the duct
- Fitting will be appropriate for regional weather conditions and installation location on exterior of building

6.6202.6k Weatherproofing

- Exterior termination fittings will be flashed or weather sealed
- Water will be directed away from penetration
- Weatherproofing will be in accordance with manufacturer specifications

6.6202.6l Pest exclusion

- Screen material no less than ¼" and no greater than ½" hole size in any direction will be used at any exhaust and intake

6.6202.6m Duct connections

- Ducts will be connected to applicable registers or grilles, collector box, HRV or ERV, intake fitting, and termination fitting
- Ducts will be connected and sealed in accordance with duct exhaust and supply duct detail

6.6202.6n Duct layout for attachment to forced air systems

- Exhaust air will not be taken from the forced air system
- Outdoor air supply ducts attached to the return side of forced air systems will be:
  - Attached as close to the HVAC system's fan as possible, while remaining in compliance with manufacturer specifications
  - Connected to the outdoor air outlet from the HRV/ERV system
  - Filtration of ventilation air will be provided before reaching the HVAC fan
  - Connected and sealed in accordance with the supply duct detail

6.6202.6o Duct layout for fully ducted HRV/ERV systems

- All ducts will be connected and sealed in accordance with Individual Exhaust Fan Serving Multiple Rooms and Ducts for Supply Fans

6.6202.6p Insulation of components

- Outdoor air intake duct will be insulated from the outdoor air intake to the HRV/ERV system to a minimum of R-8 or equivalent to local codes
- Ducts installed outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes

6.6202.6q Register boot to interior surface seal

- Register boot will be sealed to interior surfaces with sealants compatible to their intended surfaces
- Sealants will be continuous and meet fire barrier specifications

6.6202.6r Sealant selection

- Sealants will be compatible with their intended surfaces
- Sealants will be continuous and meet fire barrier specifications

6.6202.6s Balance and airflow

- Fan airflow will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to match to the design specification

6.6202.6t Fire dampers

- Fire dampers must be accessible for inspection and/or testing by the local authorities
  - If fire dampers are not accessible from a grille or register, an access door in the ductwork is required
- Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers
- Type B fire dampers will be used as required by fire code

6.6202.6u Occupant/building manager education

- Occupant/building manager will be educated on purpose of system, and also how and when to change filter and clean drain pan, if applicable, in accordance with manufacturer specifications

6.6202.9 Filtration for Fan-Powered (Active) Systems

6.6202.9a Pre-inspection

- Specifications will be field verified as appropriate to site conditions by the installer

6.6202.9b Selection of filter

- All mechanically supplied outdoor air will pass through filter before conditioning Filters and filter racks/holders will have a rating of MERV 6 or higher when tested in accordance with ASHRAE 52.2
- Pressure drop across filter will match equipment capabilities
- Filter systems that produce ozone will not be allowed

6.6202.9c Installation

- Filter will be located and installed to facilitate access and regular service by occupant/maintenance staff
- Filter will be located on the inlet side of the equipment fan
- Filter access panel will include gasket or comparable sealing mechanism and fit snugly against exposed edge of filter when closed to prevent air bypass
- Filter plenum construction will be airtight and sealed to adjoining ductwork

6.6202.9d Occupant/building manager education

- Occupant/building manager will be instructed on proper maintenance procedures and filter replacement schedule

6.6207 Passive Ventilation

6.6207.1 Passive Ventilation (All Building Types)

6.6207.1a Pre-inspection

- Specifications will be field verified as appropriate to site conditions by installer (e.g., presence of operating exhaust system, specified location, and type of trickle vent specifications)
- Access to all affected dwelling units will be ensured by installer

6.6207.1b Air intake location

- Intake will be installed in accordance with the following:
  - A minimum of 6" above grade
  - A minimum of 6' from exhaust outlets and will meet specifications of ASHRAE 62.1 Table 5-1 for all other contaminant sources
  - Above local snow or flood line
  - A minimum of 18" above an asphalt based roof

6.6207.1d Material selection

- A system that provides a proper amount of airflow in accordance with ASHRAE 62.2 will be selected that minimizes potential occupant discomfort and/or drafts

6.6207.1d Material selection

- Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications
- Sealants and materials will be continuous and meet fire barrier specifications

6.6207.1e Installation

- Install in accordance with manufacturer specifications
- Inlet will be sealed to prevent water intrusion and air leakage into building cavities

6.6207.1f Verification

- Verification of the passive inlet device will be performed and documented
- Air will flow through the device in the correct direction
- Ventilation system operation will be tested to confirm it is not causing pressure imbalances
- Room-to-room pressure differential within the dwelling unit will be no greater than 3 Pascals

6.6207.1g Occupant/building manager education

- Occupant/building manager will be educated on how the system works, and its purpose and value
- Occupant/building manager will be educated on how to inspect passive intake device upon unit turnover

6.6288 Special Considerations

6.6288.1 Sound-Rating Limits—Existing Ventilation Fans

6.6288.1a Primary ventilation system or any continuously operating fan

- System shall be rated for sound in accordance with the latest CSD-adopted version of ASHRAE 62.2

6.6288.1b Intermittent local ventilation system

- Local ventilation will be rated for sound at a maximum of 3 sone, unless their maximum rated airflow exceeds 400 CFM, in accordance with the latest CSD-adopted ASHRAE 62.2 standard

6.6288.2 Sound Ratings—New Fan Installation

6.6288.2a Primary ventilation system/continuously operating fan

- System will be rated at a sound no greater than 1.0 sone

6.6288.2b Intermittent spot ventilation system

- When installed, spot ventilation (local exhaust fans operated as needed by the occupant; e.g., range hood, bath fans) will be rated at a sound no greater than 3.0 sone

6.6288.3 Regional Climatic Considerations for Mechanical Ventilation Systems

6.6288.3a Very cold climates

- ERVs will not be installed in very cold climates unless they are equipped with frost controls
- A filter will be installed before the HRV
- Ventilation ducts will be insulated to a minimum of R-19

7. BASELOAD (ELECTRIC AND GAS)

7.8001 Refrigerators

See Section 23 Refrigerators

7.8003 Lighting & Common Area Measures

7.8003.11 Lamp (Bulb) Replacement

7.8003.11a Assessment

- Lighting strategy will be provided by lighting professional
- Work order will be evaluated against site circumstances

7.8003.11b Selection

- Lamps will be compatible with existing fixtures
- Lamps will meet the appropriate nationally recognized product standard (UL 542, UL 1570)
- Outdoor lamps will be suitable for local climate conditions and in accordance with ANSI/UL product standards
- Screw base lamp replacements will be ENERGY STAR® qualified or at least as energy efficient
- LED lamps (bulbs) will be ENERGY STAR qualified or at least as energy efficient
- Linear fluorescent lamps will not be replaced with a T12
  - At a minimum, T8 lamps will be installed
- Vandal-proof pin-based lamps will be used, if appropriate

7.8003.11c Installation

- Fixture will be de-energized before beginning work
- Worker will follow appropriate lockout procedures in accordance with CalOSHA Title 8, Subchapter 7, Section 3314 and ANSI/NFPA 70E
- Lamps will be installed in accordance with manufacturer specifications
- Lens and reflector will be cleaned

7.8003.11d Commissioning

- Relamping will be tested to meet IESNA protocol for appropriate light levels for certain tasks and emergency levels, as required by the applicable code
- Lamps will not impact required egress lighting, as required by ANSI/NFPA 101

7.8003.11e Decommissioning

- Lamps will be disposed of in accordance with EPA guidelines, local ordinances, or manufacturer specifications

7.8003.11f Occupant and worker safety

- Broken lamps containing mercury will be cleaned in accordance with EPA guidelines

7.8003.11g Building manager education

- Building manager will be provided with warranty information, product specification, and installer contact information

7.8003.11h Occupant education

- Occupants will be educated of new lamp type and benefits
  - Education will be provided by building operations staff
- Occupants will be provided with lamp disposal procedure, as determined by building operations staff
- If lamps containing mercury are used, occupants will be provided with lamp disposal procedure in accordance with EPA guidelines

7.8100 Water Heating and Water Use Reduction Measures

7.8101 Water Use Reduction

7.8101.1 Showerhead and Faucet Aerators

7.8101.1a Work assessment

- Installer pre-work assessment will be conducted to determine if plumbing needs correction before installing high-efficiency showerhead or faucet

7.8101.1b Selection

- The rated flow of new showerheads will be 1.8 gallons per minute (gpm) or less
- If multiple heads are provided, the total flow rate will not exceed 1.8 gpm
- Aerator flow rate will be 1.2 gpm or less in a bathroom/1.8 gpm or less in a kitchen
- Features will be selected that meet any special needs of the occupant (e.g., shut-off, swivel, handheld showers)

7.8101.1c Installation

- Equipment will be installed in accordance with manufacturer specifications and meet all applicable building codes
- Water quality will be evaluated for debris that may clog the equipment
- Once installed, high-efficiency showerheads or faucet aerators will be tested to determine if equipment is tightened adequately to prevent leakage at the point of connection
- If needed, shower diverter will be repaired or replaced
- Any penetrations to the exterior of the home created by the installation of the equipment will be sealed
- Any damage done to the house during installation will be repaired
- Water flow that satisfies the occupant will be provided by all showerheads and faucet aerators
  - Occupant's acceptance of the showerhead and/or aerator will be documented
- Warranty information, operation manuals, and installer contact information will be provided to the occupant
  - Specific information about proper maintenance of the equipment will be provided to the occupant

7.8101.1d Decommissioning

- Replaced showerheads and faucet aerators will be recycled or disposed of properly

7.8101.2 Low-Flow Retrofit Devices

7.8101.2a Removal

- Work area will be dry
- Care will be taken not to damage existing plumbing fixtures, finishes, and surroundings
- Unusual pressure conditions will be noted and communicated to property manager (e.g., high, low, fluctuating)
- Existing showerhead or aerator will be removed

7.8101.2b Installation

- Low-flow showerheads or aerators will be installed using a non-hardening thread sealant
- Temperature-protected shut-off valves will be used
- Showerheads with shut-off valves will not be installed in buildings with central water heating systems

7.8101.2c Commissioning

- Proper function at the fixture will be verified by turning water on to full flow
- Notification should be given to tenants informing them not to remove low-flow showerheads to maintain energy efficiency

7.8102 Installation and Replacement

7.8102.4 Storage Tank-Type Water Heater

7.8102.4a Hazardous material identification

- Health concerns in the removal and replacement of equipment (e.g., asbestos, other hazardous materials) will be identified
- Written notification will be provided to occupants of the discovery of hazardous material, including contact information for regional EPA asbestos coordinator
- Occupant will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before decommissioning and replacement (occupant is responsible for abatement or remediation)

7.8102.4b Decommissioning

- Accepted industry procedures and practices will be followed to:
  - Remove old water heater and associated components
  - Seal any unused chimney openings
  - Remove unused oil tank, lines, valves, and associated equipment

7.8102.4c New equipment installation

- New water heater and associated components will be installed in accordance with local codes, accepted industry standards and practices, and manufacturer specifications
- The system will be installed to be freeze-resistant
- Any existing water leaks will be repaired before installation begins
- Any penetrations to the exterior of the home created by the installation of the equipment will be sealed
- Seismic supports shall be designed and installed as required by code and the local jurisdiction

- In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply

7.8102.4d Drain pan

- A drain pan with a minimum depth of 1½" and sufficient size and shape to receive all dripping or condensate if leakage would cause damage to the space should be installed
- A ¾" drain line or larger will be connected to the tapping on the pan and run to an indirect drain or pumped to the outdoors

7.8102.4e Expansion tank

- A stainless steel bladder expansion tank will be installed on the cold water side
- Expansion tank shall be installed in accordance with the manufacturer's installation instructions
- A direct connection with no valves between the storage tank and expansion tank will be installed

7.8102.4f Temperature and pressure relief valve

- Correct temperature and pressure relief valve will be installed in accordance with manufacturer specifications
- Temperature and pressure relief valve discharge tube will terminate within 6" of the floor, or as prescribed by local code

7.8102.4g Dielectric unions (dielectric insulator)

- Dielectric unions (dielectric insulator) will be installed in accordance with manufacturer specifications

7.8102.4h Backflow prevention

- Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes
- Backflow devices shall be tested by a certified backflow assembly tester at the time of installation, repair, or relocation

7.8102.4i Thermal efficiency and insulation

- If additional tank insulation is installed, it will be rated a minimum of R-11 and installed to manufacturer specifications
- If additional insulation is installed, it will be installed based on fuel type, making sure not to obstruct draft diverter, pressure relief valve, thermostats, high-limit switch, plumbing pipes or elements, and thermostat access plates
- The first 6' of inlet and outlet piping will be insulated in accordance with manufacturer specifications
- Pipe insulation must remain 3" away from gas water heater vent/draft hood
- Heat traps will be installed on the inlet and outlet piping where not provided by manufacturer

7.8102.4j Required combustion air

- Combustion air shall be calculated and provided in conformance with the applicable code adopted by the jurisdiction and manufacturer's installation requirements
- In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply
- In absence of a local code, combustion air shall be calculated and provided in conformance with NFPA 54, IFGC, or NFPA 31

7.8102.4k Venting of flue gases

- Combustion byproducts shall be removed in accordance with the applicable code adopted by the jurisdiction and manufacturer's installation requirements
- In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply
- In absence of a local code, combustion byproducts shall be removed in accordance with NFPA 54, IFGC, or NFPA 31

7.8102.4l Combustion testing

- Undiluted flue gases (air-free measurement) will be checked with a calibrated flue gas analyzer in accordance with accepted protocol
- If combustion is not happening safely or to the appropriate combustion efficiency, diagnostics and adjustments will be done in accordance with manufacturer specifications and local codes

7.8102.4m Fuel supply

- Electric, natural gas, and oil supply components will be installed to accepted industry standards and codes in accordance with NFPA 70 (NEC) for electric, NFPA 54 for gas, or NFPA 31 for oil
- Energy input required by the appliance will be in accordance with manufacturer specifications (e.g., ensure gas pipe size and pressure are adequate)

7.8102.4n Discharge water temperature

- Discharge water temperature at fixtures will not exceed 120°F or as prescribed by local code
- Install mixing valve when higher storage/generation temperatures are required

7.8102.4o Commissioning of system

- The following will be checked once the system has been filled and purged:
  - Safety controls
  - Combustion safety and efficiency
  - Operational controls
  - Fuel and water leaks
  - Local code requirements
- Commissioning will be in accordance with manufacturer specifications and relevant industry standards

7.8102.4p Occupant safety

- All spaces with combustion appliances will have a carbon monoxide (CO) alarm
- Locations of CO alarms in the space shall be in accordance with state law and local codes
- Ambient CO levels will be maintained under code-acceptable thresholds

7.8102.4q Occupant education

- Completed work will be reviewed
- Occupant/building operations staff/property manager will be educated on the safe and efficient operation and maintenance of the system, including:
  - Adjustment of water temperature
  - Operation of backflow preventer and pressure regulator
  - Importance of keeping operating manuals accessible

7.8102.5 Tankless Water Heater

Tankless water heaters shall be installed only when an existing tankless water heater meets the general feasibility criteria for replacement.

7.8102.5a Hazardous material removal

- Health concerns in the removal and replacement of equipment (e.g., asbestos, other hazardous materials) will be identified
- Upon the discovery of hazardous material, written notification and contact information for regional EPA asbestos coordinator will be provided to appropriate people (e.g., occupant/building operations staff)
- Property manager will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before decommissioning and replacement (property manager is responsible for abatement or remediation)

7.8102.5b Decommissioning

- Decommission the applicable system components by completing the following, in accordance with accepted industry procedures and practices:
  - Remove old water heater and associated components
  - Seal any obsolete vent openings
  - Safely disconnect and secure any abandoned utility (fuel and electric) connections

7.8102.5c New equipment installation

- Tankless water heaters and associated components will be installed in accordance with local codes, accepted industry standards and practices, and manufacturer specifications
- In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply

7.8102.5d Drain pan

- In instances where, due to the installation location of the tankless water heater, a leak could cause damage building components, a drain pan should be installed
- A ¾" drain line or larger will be connected to the tapping on the pan and run to a floor drain, pump, or the exterior of the building

7.8102.5e Temperature and pressure relief valve

- Correct temperature and pressure relief valve will be installed in accordance with manufacturer specifications
- Equipment will be connected to a properly sized discharge tube and run to a safe location no greater than 6" from the floor or as prescribed by local code
  - In the absence of local code, the Universal Plumbing Code shall be followed

7.8102.5f Dielectric unions (dielectric insulator)

- Dielectric unions (dielectric insulator), if needed, will be installed in accordance with manufacturer specifications

7.8102.5g S Tray Voltage Protection

- Electrical connection to the water heating equipment should be made per manufacturer's instructions and per National Electric Code (NFPA 70)

7.8102.5h Backflow prevention

- Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes

- Backflow devices shall be tested by a certified backflow assembly tester at the time of installation, repair, or relocation and not less than on an annual schedule, or more frequently when required by local code

7.8102.5i Pressure verification

- Building water pressure and volume will be verified as sufficient and will be in accordance with manufacturer specifications
- A pressure regulator or booster pump will be installed as needed

7.8102.5j Pipe insulation

- All piping and fittings will be insulated with fixed insulation to IECC or ASHRAE 90.1, at a minimum

7.8102.5k Required combustion air

- It is recommended, when a tankless water heater will be installed, that the tankless appliance be sealed (closed) combustion
- If not possible:
  - Combustion air shall be calculated and provided in conformance with the applicable code adopted by the jurisdiction and manufacturer's installation requirements
  - In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply
  - In absence of a local code, combustion air shall be calculated and provided in conformance with NFPA 54, IFGC, or NFPA 31

7.8102.5l Venting of flue gases

- Combustion byproducts shall be removed in accordance with the applicable code adopted by the jurisdiction and manufacturer's installation requirements
- In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply
- In absence of a local code, combustion byproducts shall be removed in accordance with NFPA 54, IFGC, or NFPA 31

7.8102.5m Combustion testing

- Undiluted flue gases will be checked with a calibrated flue gas analyzer in accordance with accepted protocol
- If combustion is not happening safely or to maximum efficiency, diagnostics and adjustments will be done in accordance with manufacturer specifications and local codes

7.8102.5n Fuel supply

- Electric, natural gas, and oil supply components will be installed to accepted industry standards and codes in accordance with NFPA 70 (NEC) for electric, NFPA 54 for gas, or NFPA 31 for oil
- Energy input required by the appliance will be in accordance with manufacturer specifications (e.g., ensure gas pipe size and pressure are adequate)

7.8102.5o Discharge water temperature

- Discharge water temperature will be set not to exceed 120°F or as prescribed by local code
- Install mixing valve when higher storage/generation temperatures are required

7.8102.5p Commissioning of system

- The following will be checked once the system has been connected and filled:
  - Safety controls
  - Combustion safety and efficiency
  - Operational controls
  - Fuel and water leaks
  - Cycle unit
  - Local code requirements
  - Other system components (e.g., expansion tank, storage tank)
- Commissioning will be in accordance with manufacturer specifications and relevant industry standards

7.8102.5q Ambient carbon monoxide (CO)

- All spaces with combustion appliances will have a CO alarm
- Locations of CO alarms in the space shall be in accordance with state law and local codes
- Ambient CO levels will be maintained under code-acceptable thresholds

7.8102.5r Building manager education

- Completed work will be reviewed
- Occupant/building manager will be educated on the safe and efficient operation and maintenance of the system, including:
  - Adjustment of water temperature
  - Operation of backflow preventer and pressure regulator
  - Importance of keeping operating manuals accessible

7.8102.8 Heat Pump Water Heater

7.8102.8a Hazardous material removal

- Health concerns in the removal and replacement of equipment (e.g., asbestos) will be identified
- Upon the discovery of hazardous material, written notification and contact information for regional EPA asbestos coordinator will be provided to appropriate people (e.g., occupant/building operations staff/property manager)
- Property manager will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before decommissioning and replacement (property manager is responsible for abatement or remediation)

7.8102.8b Decommissioning

- Decommission the applicable system components by completing the following in accordance with accepted industry procedures and practices:
  - Remove old water heater and associated components
  - Seal any obsolete vent openings
  - Safely disconnect and secure any abandoned utility (fuel and electric) connections at source

7.8102.8c Equipment accessibility

- A level working space not less than 30" in length and 30" in width shall be provided in front of the control side to service an appliance

- Water heaters shall be installed in accordance with their listings and the manufacturer's installation instructions
- Appliance will be installed and plumbed to allow for inspection, maintenance, and replacement of the appliance and its components, without disturbing any installed equipment, controls, piping, and components, other than what requires repair/ replacement
- Anode rod will be accessible for replacement

7.8102.8d Equipment location

- Appliance will be located to minimize noise impact, when possible
- Appliance will be located to maximize efficient operation and auxiliary benefits (e.g., dehumidification)

7.8102.8e New equipment installation

- A new water heater and associated components will be installed in accordance with local codes, accepted industry standards and practices, and manufacturer specifications
- In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply
- In instances where a leak could cause damage, a drain pan will be installed under the storage tank in accordance with manufacturer specifications and the following criteria:
  - Connected to ¾" drain line or larger to tapping on pan
  - Run to drain, pump, or daylight

7.8102.8f Drain pan

- In instances where a leak could cause damage, a drain pan will be installed in accordance with manufacturer specifications and the following criteria (Uniform Plumbing Code 5.10.7, International Residential Code 20801.5.1):
  - Connected to ¾" drain line or larger to tapping on pan
  - Run to drain, pump, or daylight

7.8102.8g Temperature and pressure relief valve

- Correct temperature and pressure relief valve will be installed in accordance with manufacturer specifications
- Equipment will be connected to properly sized discharge tube and run to a safe location no greater than 6" from the floor or as prescribed by local code
  - In the absence of local code, the Uniform Plumbing Code shall be followed
- There will be no shut-off valve installed on the discharge tube

7.8102.8h Dielectric unions (dielectric insulator)

- Dielectric unions (dielectric insulator), if needed, will be installed in accordance with manufacturer specifications

7.8102.8i Stray voltage protection

- Electric water heating equipment should be installed per the National Electrical Code (NFPA 70)

7.8102.8j Backflow prevention

- Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes

- Backflow devices shall be tested by a certified backflow assembly tester at the time of installation, repair, or relocation, and not less than on an annual schedule or more often where required by local code

7.8102.8k Pressure verification

- Water pressure and volume capacity of the building will be verified as sufficient to be in accordance with manufacturer specifications
- A pressure regulator or booster pump will be installed as required

7.8102.8l Pipe insulation

- All piping and fittings will be insulated with fixed insulation to IECC or ASHRAE 90.1, at a minimum

7.8102.8m Required air

- Ventilation and clearances for adequate heat transfer will be provided in accordance with manufacturer specifications

7.8102.8n Electric supply

- Electric supply components will be installed to accepted industry standards and codes in accordance with National Electric Code (NFPA 70)
- Energy input required by the appliance will be in accordance with manufacturer specifications

7.8102.8o Discharge water temperature

- Discharge water temperature will be set not to exceed 120°F or as prescribed by local code
- Install mixing valve when higher storage/generation temperatures are required

7.8102.8p Commissioning of system

- The following will be checked once the system has been connected and filled:
  - Safety controls
  - Operational controls
  - Water leaks
  - Cycle unit through modes
  - Filter
  - Other system components (e.g., expansion tank, storage tank)
  - Temperature set point
- Manufacturer specifications and all relevant industry standards will be met in commissioning

7.8102.8q Occupant/building manager education

- Completed work will be reviewed
- Occupant/building manager will be educated on the safe and efficient operation and maintenance of the system, including:
  - Adjustment of water temperature
  - Operation of backflow preventer and pressure regulator
  - Filter replacement
  - Importance of keeping operating manuals accessible

7.8102.9 Non-Fired Storage Tank

7.8102.9a Hazardous material removal

- Health concerns in the removal and replacement of equipment (e.g., asbestos) will be identified
- Upon the discovery of hazardous material, written notification and contact information for regional EPA asbestos coordinator will be provided to appropriate people (e.g., occupant/building operations staff/property manager)
- Property manager will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before decommissioning and replacement (property manager is responsible for abatement or remediation)

7.8102.9b Decommissioning

- Decommission the applicable system components by completing the following in accordance with accepted industry procedures and practices:
  - Remove old water heater and associated components
  - Seal any obsolete vent openings
  - Safely disconnect and secure any abandoned utility (fuel and electric) connections

7.8102.9c Site security

- Worksite will be secured to prevent unauthorized entry
- Temporarily disconnected equipment will be locked up and tagged out
- All trash and unused materials will be removed from work site daily

7.8102.9d Equipment accessibility

- Storage tank will be installed and plumbed to allow for inspection, maintenance, and replacement of the tank and its components
- Anode rod, when present, will be accessible for replacement

7.8102.9e Storage tank location

- Storage tank will be located to maximize efficient operation of the water heating system

7.8102.9f Storage tank installation

- Verify storage tank size will meet the building water requirements
- A new storage tank and associated components will be installed in accordance with accepted industry standards and practices and manufacturer specifications
- Storage tanks will be installed level, with seismic bracing, and in a manner to prevent rust and corrosion
- Storage tank will be installed on a housekeeping pad
- Storage tanks shall be placed in a location that does not obstruct building egress or access, as required by local codes adopted by the authority having jurisdiction

7.8102.9g Drain pan

- A drain pan will be installed in accordance with storage tank manufacturer specifications and the following criteria:
  - Connected to ¾" drain line or larger to tapping on pan
  - Run to drain, pump, or daylight

7.8102.9h Temperature and pressure relief valve

- Correct temperature and pressure relief valve will be installed in accordance with manufacturer specifications
- Storage tank will be connected to properly sized discharge tube and run to a safe location no greater than 6" from the floor or as prescribed by local code
  - In the absence of local code, the Uniform Plumbing Code shall be followed

7.8102.9i Dielectric unions (dielectric insulator)

- Dielectric unions (dielectric insulator), if needed, will be installed in accordance with manufacturer specifications

7.8102.9j Stray voltage protection

- Electrical connection to the water heating equipment should be made per manufacturer's instructions and per the National Electric Code (NFPA 70)

7.8102.9k Insulation

- All piping and fittings will be insulated with fixed insulation to IECC (International Energy Conservation Code) or ASHRAE 90.1, at a minimum
- Tanks will be internally insulated to a minimum of R-12.5

7.8102.9l Electric components

- Electric components will be installed to accepted industry standards and codes in accordance with National Electrical Code (NFPA 70)

7.8102.9m Discharge water temperature

- Discharge water temperature will be set not to exceed 120°F or as prescribed by local code
- Install mixing valve when higher storage/generation temperatures are required

7.8102.9n Gauges

- Temperature and pressure gauges on storage tank will be installed and visible

7.8102.9o Valves

- Valves will be installed to isolate tank from water heating system and to allow for bypass in multiple tank systems

7.8102.9p Commissioning of system

- The following will be checked once the system has been connected and filled:
  - Safety controls
  - Operational controls
  - Valves
  - Water leaks
  - Temperature set point
- Manufacturer specifications and all relevant industry standards will be met in commissioning

7.8102.9q Occupant/building manager education

- Completed work will be reviewed
- Occupant/building manager will be educated on the safe and efficient operation and maintenance of the system, including:
  - Adjustment of water temperature
  - Proper use of isolation valves

- Need for inspection and replacement of anode rod
- Importance of keeping operating manuals accessible

7.8103 Water Heater Maintenance/Inspection

7.8103.3 Water Heater System Purging

7.8103.3a System analysis

- Water piping will be analyzed to identify air collection points (e.g., highpoints, deadheads, side-plumbed tanks, large pumps)

7.8103.3b Order of purging water heater

- Purging will be done in the following order:
  - New equipment
  - Entire system
  - Verify equipment

7.8103.3c Purge new equipment

- Equipment will be purged in accordance with manufacturer specifications

7.8103.3d Purge system

- System will be manually purged using water pressure
- Auto air vents will not be relied on for purging
- Purging of air collection points (e.g., highpoints, deadheads, side-plumbed tanks, large pumps) will be verified

7.8103.3e Verify purging of new equipment

- Equipment will be purged in accordance with manufacturer specifications

7.8103.3f Energize water heater system

- System will be energized and checked for air noise

7.8104 Hot Heater Distribution System

7.8104.3 Water Heater Piping

7.8104.3a Hazardous material removal

- Health concerns in the removal and replacement of equipment (e.g., asbestos) will be identified
- Upon the discovery of hazardous material, written notification and contact information for regional EPA asbestos coordinator will be provided to occupant/ building operations staff/building manager
- Property manager will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before decommissioning and replacement
  - Building manager is responsible for abatement or remediation

7.8104.3b Removal

- Visible abandoned piping will be removed
- Obsolete but inaccessible piping will be capped as close as possible to point of no access

7.8104.3c Location

- Piping will be installed to minimize length
- Hot water piping will be purposely located to allow for insulation of each individual pipe (e.g., no bundling)
- Piping will be located with the following priority:
  - Within conditioned space
  - Within the building
  - Outdoors
- Piping will not be placed in locations prohibited by adopted building codes, e.g., exit stairs enclosures, exit passageways, and electrical equipment rooms
- Piping will be installed to protect occupant/building management/building operations staff from hot water pipes

7.8104.3d Water heater and pipe insulation

- All piping and fittings will be insulated with fixed insulation to IECC or ASHRAE 90.1, at a minimum
- Tanks will be internally insulated to a minimum of R-12.5
- Insulation will be protected from damage (e.g., protected from underground water, contact, friction from pipe hangers, woodpeckers, ultraviolet radiation)

7.8104.3e Friction loss

- Friction loss will be minimized using the following criteria:
  - Smooth piping
  - Minimized number of fittings
  - Sweeps will be selected instead of 90° elbows
  - Full port valves

7.8104.3f Dissimilar metals

- Dissimilar metals shall be connected in a manner to prevent galvanic corrosion
- When connecting nonferrous metal piping to existing ferrous piping, dielectric unions (dielectric insulator) will be installed in accordance with manufacturer specifications
- Alternatively, if dielectric unions are not required by code, consider using a plastic-lined steel nipple a minimum of 4" long to connect the two piping systems to separate dissimilar metals

7.8104.3g Bracing and hangers

- Piping, fixtures, appliances, and accessories shall be adequately supported in accordance with the manufacturer's installation instructions and in accordance with the authority having jurisdiction

7.8104.3h Stray voltage protection

- Piping will be bonded and grounded as required by National Electrical Code (NFPA 70)

7.8104.3i Commissioning

- Piping will be charged (filled with water) and checked for leaks

7.8104.8 Domestic Hot Water Expansion Tank (Potable Water)

7.8104.8a Adequate air pressure of existing air tank

- Unit will be hydraulically isolated and removed from piping and drain tank

- Cap will be removed on bottom of tank
- Pressure will be checked using a pressure gauge
- Pressure will be closely matched to incoming water pressure

7.8104.8b Proper sizing of new expansion tank

- Collect necessary information to determine expansion tank size, including:
  - Operating water pressure of water heater
    - A pressure gauge may need to be installed for verification
  - Water heater and tank volume
  - Operating water temperature
  - Relieve valve pressure setting
  - Value of incoming street water pressure

7.8104.8c Pre-charge air pressure in new expansion tank

- Using a tire pressure gauge and a tire pump to adjust as necessary, pressure in potable water expansion tank will be set to match the incoming street water pressure

7.8104.8d New installation location of expansion tank

- When required by the local jurisdiction, an expansion tank shall be installed in accordance with the manufacturer's installation instructions
- The expansion tank will be located on the cold water inlet to the water heater
- The expansion tank should be located between the water heating equipment and the required shut-off

Table of Contents

1. THE WEATHERIZATION FIELD TEAM

1.1 The Weatherization Field Team consists of three roles:

1.1.1 Assessor/Energy Auditor (EA)

1.1.2 Crew Leader/Installer

1.1.3 Inspector

1.2 The purpose of this document is to provide guidance to assessors, crew leaders, installers, and inspectors in the performance of their duties within CSD's weatherization program.

1.2.1 CSD policies pertaining to the function of these job roles are provided within this document; however, unforeseen circumstances may require that these policies be temporarily or permanently revised. Revised policies will be published in a CSD Program Notice (CPN), CSD Program Advisory (CPA), or contract and posted to the Providers' website in conformance with CSD policy.

1.3. Weatherization Timelines

Timely communication is critical between the members of the Weatherization Field Team. Timelines for the home assessment, diagnostic tests, and other time-sensitive procedures for weatherization work are described in Table G-1 below:

TABLE G-1: WEATHERIZATION TIMELINES

Timeline	Time Maximums
From certification date to assessment	Qualification certifications are valid for no more than 120 days. If the eligibility certification expires before a full assessment is performed, the agency must recertify income eligibility before weatherization work is begun.
From pre-combustion appliance safety (CAS) to post-CAS test	No more than 60 days, or pre-test must be repeated before any weatherization work is begun.
From assessment date to job completion	Once assessed, the home must be completely served within 180 days from the assessment, including the post-inspection. If the weatherization work cannot be completed within 180 days, the agency shall obtain updated income verification documentation to recertify the household's income eligibility before further weatherization work can continue.

1.4. Separation of Duties

1.4.1 Assessments/Energy Audits

1.4.1(a) Agencies shall ensure job separation between staff performing dwelling assessments and the crew responsible for performing the actual installation of weatherization measures. Assessors may not install weatherization measures in the same dwelling where that assessor performed the assessment for weatherization services.

1.4.1(b) If an agency elects to subcontract outside of CSD's agency network for the full installation of weatherization measures, the subcontractor performing the installation of weatherization measures shall not perform the dwelling assessment. Agencies shall ensure job separation by using the agency's staff or another subcontractor to perform dwelling assessments.

1.4.2 Crew Leader/Installer

1.4.2(a) Measure installation activities shall not be performed by the same agency or subcontractor field personnel who have conducted the assessment of, or who will conduct the post-weatherization inspection of, the same dwelling.

1.4.3 Inspectors

1.4.3(a) The agency shall ensure job separation between staff performing post-weatherization inspection activities and weatherization crew personnel performing the physical installation and performance of weatherization measure services.

1.4.3(b) Subcontractor: If an agency elects to subcontract outside of CSD's agency network for the full installation of weatherization measures, the subcontractor performing the installation of weatherization measures shall not perform the post-weatherization inspection. The agency shall ensure job separation by using the agency's staff or another subcontractor to perform the dwelling post-weatherization inspection.

1.4.4 Exemption Requests

1.4.4(a) An exemption to the separation-of-duties requirement may be granted for agencies for which it is economically challenging and/or operationally impractical to achieve job separation.

1.4.4(b) An agency program manager must make a request in writing to CSD and receive an affirmative written response from CSD for this to be an "approved" exception. The request must include additional safeguards that the agency will implement to ensure quality of workmanship.

1.5. Field Personnel Training Requirements

1.5.1 All field personnel are required to complete CSD's training requirements in accordance with the CSD policy and their employer's (agency or subcontractor) internal training policies to ensure that all mandatory field practices are followed. For information on training requirements, refer to the "Training" page on the Providers' website.

1.6. Fail Correction Timelines

1.6.1 In all phases of field work (assessment, installation, or post-inspection), upon discovery of a combustion appliance hazard or fail, or measure installation fail, the following correction timeline will be enforced:

1.6.1(a) When a hazard is identified, the issue must be mitigated within 24 hours and fully resolved within five working days.

1.6.1(a1) If a gas leak is found, all other weatherization actions must stop immediately until the leak is addressed.

- Exception: If a water heater is temporarily abandoned to alleviate a hazard, the appliance condition must be completely resolved within five working days.

1.6.1(a2) Once the hazard is resolved (may be a temporary remedy), CSD considers an identified issue to be non-hazardous from that point on and subject to the non-hazardous timeline described below.

1.6.1(b) All non-hazardous conditions noted by the assessor/auditor shall be corrected within 20 working days of written notification by the assessor in the CSD 540 Dwelling Assessment Form.

1.6.1(b1) A qualified technician or contractor licensed to work on that appliance must isolate the specific problem and determine the estimated cost to repair the defective unit before the agency decides if the defective unit must be repaired or replaced.

1.6.1(b2) Appliances that require repair or replacement under Health & Safety, or as an energy efficiency upgrade measure, shall be noted and reported to supervisors as required, and in accordance with the agency's policy.

1.6.2 The time periods for correction may be extended for circumstances beyond the agency's control; however, a waiver must be approved in writing by CSD prior to the expiration of the original timeline.

2. ASSESSOR RESPONSIBILITIES AND POLICIES

2.1. Assessor Job Role

2.1.1 Assessors must observe what conditions are present in a home, and evaluate what measures are feasible. Assessment of the entire interior and exterior of a home is required, including building shell, attics, crawlspaces, appliances, and the mechanical, electrical, and plumbing systems (Fig. G-1).

2.1.2 Assessors must be familiar with the feasibility criteria for each measure and proficient in all diagnostic testing.

2.1.3 An assessor shall ensure that the responsibilities identified in Table G-2 are completed in conformance with CSD policy and procedures.

Source: WAPTAC.org

FIG. G-1: ASSESSMENT

TABLE G-2: DOCUMENTS GUIDING ASSESSOR RESPONSIBILITIES

Assessor Responsibility	Policy Reference
1. Ensure that assessment equipment is functional, up-to-date, and calibrated when required.	Standard Assessment Equipment Appendix A Combustion Appliance Safety Protocol Appendix B Duct Leakage Testing Protocol Appendix C Shell Leakage Testing Protocol
2. Evaluate dwelling eligibility. Review existing conditions and potential for energy efficiency measures. Collect photographic documentation, if required.	Dwelling Eligibility (All Dwelling Types) Dwelling Assessment Policies Required Photographs (Justification Images) Appendix E Health and Safety Requirements
3. Determine what weatherization contract(s) will be charged to ensure that protocols are followed correctly.	Dwelling Eligibility (All Dwelling Types) CSD contracts, Providers' website
4. Determine if home qualifies for review as mandated by the State Historic Preservation Office (SHPO) when dwelling is ≥45 years old.	State Historic Preservation Review CSD contracts, Providers' website
5. Evaluate home for major structural defects, indoor air quality (IAQ) hazards, structural hazards, or other deferral conditions that may limit weatherization.	Dwelling Assessment Policies Appendix E Health and Safety Requirements
6. Inform the client of the various types of diagnostic testing to be performed, including the general nature and benefits of each type. Conduct a visual inspection to identify deficiencies that would inhibit pressurized diagnostics to occur.	Permission to Weatherize Appendix A Combustion Appliance Safety Protocol Appendix B Duct Leakage Testing Protocol Appendix C Shell Leakage Testing Protocol

TABLE G-2: DOCUMENTS GUIDING ASSESSOR RESPONSIBILITIES

Assessor Responsibility	Policy Reference
7. Perform diagnostic testing in accordance with Appendices A, B, and C. Note: CAS is part of the assessment. Duct and shell leakage testing may be performed as part of initial assessment or performed prior to weatherization by the trained installers. When conducting an energy audit, duct and shell leakage testing should be performed at time of assessment.	Diagnostic Tools CAS Checks Section 1 General Installation Guidelines
8. Determine if home qualifies for an energy audit and collect audit data, when applicable.	Assessment Documentation Appendix D Energy Audit/Priority List Protocol
9. Collect refrigerator data to verify measure feasibility (metering, appliance plate, etc.)	Assessment Documentation Section 23 Refrigerators
10. Collect mechanical ventilation data to determine measure feasibility, when required by program.	Assessment Documentation Section 12 Mechanical Ventilation
11. Provide mathematical calculations to justify all claims of catastrophic leakage (when allowed by program)	Assessment Documentation Section 32 Infiltration Reduction
12. Document all findings in the required CSD form when applicable. A hard copy or electronic copy of all assessment forms, with all additional notes shall be kept in the client file.	Assessment Documentation CSD forms, Providers' website
13. Provide client education and obtain client signature on the CSD 321 Client Education Confirmation of Receipt form. A signature may be in writing or electronic.	Assessment Documentation CSD forms, Providers' website
14. Identify measure installations that would require a permit by the local jurisdiction, and educate the home owner about the permit process if necessary.	Permit-Related Education Section 1 General Installation Guidelines
15. Compile and complete the work order, based on the assessment results. Transmit client file to the installation team.	Required procedure defined by agency's internal policy

2.2. Assessment Documentation

2.2.1 The standard CSD assessment forms (or permitted contractor's equivalent forms that have been pre-approved by CSD) shall be used to conduct all home assessments including, but not limited to, the forms listed below.

2.2.2 Required Forms

2.2.2(a) The feasibility of each measure must be evaluated and documented on the CSD 540 Dwelling Assessment Form. If a measure is not feasible, the justification must be described clearly and accurately.

2.2.2(a1) The assessment shall be completed and documented before leaving the dwelling. A drawing of the house "footprint" shall be included when insulation will be installed.

2.2.2(a2) The CSD 540A Weatherization Mold/Moisture Assessment and Release Form shall be completed for every dwelling assessed and include a description of any moisture or mold issues observed.

2.2.2(a3) The CSD 540C Whole-Dwelling Ventilation Calculation Worksheet and CSD 540D Mechanical Ventilation Assessment Form shall be completed on- or off-site to document the feasibility of mechanical ventilation. (See Section 12 Mechanical Ventilation.)

2.2.2(a4) The CSD 540E Single-Family Refrigerator Savings-to-Investment Ratio (SIR) Calculation Worksheet v1.3 shall be used on- or off-site to calculate the feasibility of a replacement refrigerator. (See Section 23 Refrigerators.)

2.2.2(a5) Assessments shall include diagnostic testing, as applicable, and test results shall be required on the:

- CSD 700 Combustion Appliance Safety Inspection Form (see Appendix A Combustion Appliance Safety Protocol)
- CSD 704 Shell Leakage Data Sheet (see Appendix C Shell Leakage Testing Protocol)
- CSD 706 Duct Leakage Data Sheet (see Appendix B Duct Leakage Testing Protocol)

2.2.2(a6) When an energy audit and/or priority list will be used for DOE WAP jobs, the following forms will apply (see Appendix D Energy Audit/Priority List Protocol).

- The CSD 544 Single-Family/Small Multi-Family Audit Input Report mirrors the REM/Design data collection software inputs to ensure all data is collected while present during the on-site visit.
- The CSD 710 DOE Priority List Checklist form is used to verify the decision-making process relative to use of the energy audit and the Priority List tables.
- The CSD 808 Small Multi-Family Input Cost Sheet is used to allocate unit-level data when small multi-family projects are completed.
- The CSD 871 Pre-Weatherization Scope of Work (SOW)/Sources & Uses (S&U) Tool: shall be completed for Targeted Retrofit Energy Analysis Tool (TREAT) audits. This spreadsheet is completed prior to the initial technical review to identify the proposed measure energy savings, measure cost, effective useful life (EUL), and SIR.
- The CSD 872 Post-Weatherization Scope of Work (SOW)/Sources & Uses (S&U) Tool is also completed for TREAT audits, and is completed following the measure installation to confirm the final measure costs, SIR, EUL, etc.

2.2.3 Required Photographs (Justification Images)

2.2.3(a) The following assessment photographs are required, and must be kept in the client file or stored electronically with an agency standardized format for the file name (i.e., by client name, address, or job number):

2.2.3(a1) Photographs to inform the client of the conditions in the home where a new measure (or the repair/replacement of an existing measure) is warranted and the area is not easily accessible to the client, such as in an attic or crawlspace including attic and floor insulation, duct work, electrical hazards, etc.

- The photographs will provide information to the client about the existing conditions and explain why the new measure, or repair/replacement of the existing measure is necessary.

2.2.3(a2) Photographs to justify waiver requests as specified on the CSD Waiver Request Form (Providers' website).

2.2.3(a3) Photographs to document improvement measures to be considered by the SHPO.

2.2.3(a4) Photographs to document identified deferral conditions.

2.2.3(a5) Photographs to document lead-safe weatherization and clean-up activities.

2.2.3(a6) Photographs required for the REM/Design energy audit (listed separately in the Appendix D Energy Audit/Priority List Protocol).

2.2.3(a7) Photographs required to document CAS conditions.

2.3. Standard Assessment Equipment

2.3.1 Assessors shall carry all necessary tools and safety equipment to perform their job duties. At a minimum, assessors shall have available the following basic tools.

2.3.2 Diagnostic Tools

2.3.2(a) All CAS, duct leakage, and shell leakage test equipment used by assessors and other field personnel shall conform to the specifications provided in the Appendix A Combustion Appliance Testing Protocol, Appendix B Duct Leakage Testing Protocol, and Appendix C Shell Leakage Testing Protocol.

2.3.3 Hand Tools

2.3.3(a) Measuring tape (minimum 25')

2.3.3(b) Electrical outlet tester

2.3.3(c) Screwdriver sets (Phillips and slotted)

2.3.3(d) Calculator

2.3.3(e) Clipboard

2.3.4 Ladders

2.3.4(a) Minimum 6' stepladder and

2.3.4(b) Minimum 12' extension ladder or

2.3.4(c) Combination ladder that performs both functions

2.3.5 Personal Protective Equipment (PPE)

2.3.5(a) PPE as defined by Appendix E Health and Safety Requirements shall be worn (Fig. G-2).

Fig. G-2: Personal Protective Equipment

2.4. Dwelling Eligibility (All Dwelling Types)

2.4.1 Three-Measure Minimum

2.4.1(a) All dwellings that have not been previously weatherized under a CSD program or other program may qualify for weatherization if three mandatory measures are feasible. The three mandatory measure policy requirements for LIHEAP and the DOE WAP are: 1) Ceiling insulation plus two additional mandatory measures, or 2) In the event that ceiling insulation is already in place or is not feasible, at least three mandatory measures are installed. In addition:

2.4.1(a1) If the required minimum number cannot be installed due to the deferral of measures, then the entire unit shall be deferred on the CSD 542 Weatherization Deferral form.

2.4.1(a2) LIHEAP optional measures cannot be counted toward the three-measure minimum to qualify a home for first-time weatherization unless all mandatory measures are unfeasible.

2.4.1(a3) Assessments, diagnostic testing, and post inspections shall not be counted toward the three-measure minimum unless specifically allowed by the program contract.

2.4.1(a4) Emergency health and safety measures provided under the Energy Crisis Intervention Program (ECIP) Emergency Heating and Cooling Services (EHCS) may be installed without meeting the three-measure rule.

2.4.1(a5) ECIP EHCS dwellings shall be referred for weatherization services and, if measures are installed within 180 days, the measures installed under ECIP EHCS shall count toward the three-measure rule. Note: All other dwelling and client eligibility requirements shall apply to ECIP as to LIHEAP.

2.4.2 Multi-Unit Dwelling Eligibility Requirements

2.4.2(a) For multi-unit buildings, in addition to the eligibility requirements for the previous section:

2.4.2(a1) The 66/50 Rule shall be applied, as defined in Appendix D Energy Audit/Priority List Protocol - LIHEAP - DOE WAP.

2.4.2(a2) Installation of ceiling insulation may be counted as a ceiling insulation measure for each unit within a multi-unit building envelope.

2.4.2(a3) Installation of a common (multi-family) water heater shall qualify as a mandatory measure for each unit served by the same water heater.

2.4.2(a4) Whole building policies shall be applied as defined in Appendix D Energy Audit/Priority List Protocol - LIHEAP - DOE WAP.

2.4.2(a5) Individual unit weatherization policies shall be applied as defined in Appendix D Energy Audit/Priority List Protocol - LIHEAP - DOE WAP.

2.4.2(a6) Vacant and over-income unit policies shall be applied as defined in Appendix D Energy Audit/Priority List Protocol - LIHEAP - DOE WAP.

2.4.3 Ineligible Dwellings (All Dwelling Types)

2.4.3(a) Assessors shall not assess any dwelling unit that:

2.4.3(a1) Will be acquired or cleared by a federal, state, or local program within 12 months from the date weatherization would be completed

2.4.3(a2) Does not have written permission of the property owner/tenant on the CSD 515A Energy Service Agreement for Occupant and CSD 515B Energy Service Agreement for Property Owner

2.4.3(a3) Is an institutional or commercial building including, but not limited to, universities, schools, nursing homes, hospital, shelters, or group homes. Note: Only DOE WAP allows weatherization services on shelters and group homes.

2.4.3(a4) Is listed for sale at the time of qualifying for the program or will be offered for sale within 60 days after the completion of weatherization

2.4.3(a5) Is a single-family or manufactured/mobile home of <330 sq. ft. of living space. Note: This policy does not apply to multi-family dwellings.

2.4.3(a6) Is a travel trailer, boat, or other transportable dwelling type

2.4.4 Call-Backs and Re-Weatherization Policies

2.4.4(a) In CSD weatherization, a “call-back” is when a measure fails and is required to be corrected by an agency. Additional work on a completed unit shall be classified as a call-back when:

2.4.4(a1) The client notifies the agency within the contractor warranty period that a measure has failed or

2.4.4(a2) During a CSD or third-party inspection, any feasible measure that was not installed or failed measure is found that requires correction.

2.4.4(b) For call-backs associated with the DOE WAP, contact CSD.

2.4.4(b1) CSD strongly encourages the use of LIHEAP funds for call-backs.

2.4.4(c) Once a dwelling has been submitted to CSD for reimbursement as a completed unit (under LIHEAP or DOE WAP), any later weatherization service that is not a call-back provided to the home is considered “re-weatherization.”

2.4.4(d) To confirm a dwelling’s eligibility for DOE WAP, Local Service Providers (LSPs) must check their historical dwelling service records to confirm there is no prior history of DOE WAP services for the dwelling.

2.4.4(e) Weatherization services for a dwelling unit previously weatherized using DOE WAP and DOE American Recovery and Reinvestment Act (ARRA) funds are not allowable unless:

2.4.4(e1) Further weatherization would be performed at least 15 years after previous weatherization services were completed

- This applies to any dwelling weatherized utilizing any federal funding, including DOE, LIHEAP, HUD, or USDA.

2.4.4(f) Under the LIHEAP weatherization and ECIP EHCS programs, re-weatherization is only allowed when:

- A previously installed measure is reinstalled during its EUL due to premature failure of the measure (outside of the warranty period). Written justification must be kept in the client file.
- The measure was destroyed by the prior occupying household
- The EUL has already expired for a previously applied measure
- The dwelling has been previously weatherized under a CSD or other or another federal or non-federal program, agencies may provide previously unapplied mandatory and optional measures within the dollar limits of the contract.

2.4.4(g) Client recertification requirement

2.4.4(g1) Call-back: Client is not recertified.

2.4.4(g2) Re-weatherization: Client must be recertified if client eligibility has expired.

2.4.4(h) Three-measure minimum requirement

2.4.4(h1) Call-back: Three-measure minimum does not apply.

2.4.4(h2) Re-weatherization: If a dwelling has been previously weatherized under a CSD weatherization program, the dwelling may be assessed for previously unapplied measures.

2.5. Permission to Weatherize

2.5.1 For a home to qualify for services, not only must the occupants be income-qualified, but the owner of the property must give permission for the work to be completed. CSD's weatherization permission forms are CSD 515A Energy Service Agreement for Occupant and the CSD 515B Energy Service Agreement for Property Owner.

2.5.2 Once weatherization work has begun in a home, if significant structural or engineering issues are discovered (see "Structural/Engineering Issues" in Appendix H Reference Documents, Definitions) or if environmental or Health & Safety hazards are present, work must stop until the agency re-obtains the property owner's permission for the revised scope of work.

2.5.3 Client Refusal of a Measure

2.5.3(a) In general, CSD's weatherization programs are voluntary. If a client does not want a particular measure installed, it shall not be installed; however, assessors shall obtain a written statement from the client regarding the measure(s) that are refused, with the client's signature and the date.

2.5.3(b) By CSD policy, if a client refuses a measure, the measure shall not be feasible for that dwelling until a new occupant becomes the tenant or homeowner.

2.5.3(c) Measure refusal shall be documented on the CSD 540 Dwelling Assessment Form and/or the CSD 710 Energy Audit and Priority List Checklist (for DOE WAP jobs). Refusal of a DOE WAP energy conservation measure shall have consequences as identified in Appendix D Energy Audit/Priority List Protocol.

2.5.4 Client Refusal of a Diagnostic Test

2.5.4(a) When a client refuses a diagnostic test, education shall be provided to the client advising them of the reasons for and the benefits of such testing, and informing them that refusal prevents installation of specific measures (LIHEAP) or may require the deferral of all weatherization work (DOE WAP).

2.5.4(b) Client refusal of the diagnostic test must be documented on the CSD 542 Weatherization Deferral form and signed by the client. If a client refuses to sign in acknowledgment of the deferral condition(s), the Assessor must document this refusal to sign on the CSD 542 Weatherization Deferral form.

2.5.4(c) Client refusal of a diagnostic test shall result in a limited or full deferral according to the specifications in Table G-3:

TABLE G-3: REFUSAL OF DIAGNOSTIC TEST

When a Client Refuses the…		
CAS Test	**Duct Leakage Test**	**Shell Leakage Test**
DOE WAP: Defer dwelling	**DOE WAP:** Defer dwelling	**DOE WAP:** Defer dwelling
LIHEAP: Defer dwelling	**LIHEAP:** If no CAS/IAQ fail is present: • Seal catastrophic leaks only and report on the CSD 706 Duct Leakage Data Sheet.* If a CAS/IAQ fail is present: • When corrected, seal catastrophic leaks only and report on the CSD 706 Duct Leakage Data Sheet.* • When not correctable within program scope, the dwelling is limited to non-infiltration reduction measures ([home is NIM).	**LIHEAP:** If no CAS/IAQ fail is present, or no blower door test is performed: • Prescriptively seal, following prioritization in accordance with the CSD 704 Shell Leakage Data Sheet.* If a CAS/IAQ fail is present and a blower door test is performed: • When corrected, seal following prioritization in accordance with the CSD 704 Shell Leakage Data Sheet.* • When not correctable within program scope, the dwelling is NIM.
*The Appendix B Duct Leakage Testing Protocol, the Appendix C Shell Leakage Testing Protocol, and the sealing prioritization on the CSD 704 Shell Leakage Data Sheet and CSD 706 Duct Leakage data Sheet forms shall be followed without exception.		

2.6. Dwelling Assessment Policies

2.6.1 Dwelling and Occupant Safety Evaluations

2.6.1(a) Assessment of a home requires an evaluation to ensure that:

2.6.1(a1) Occupants' health will not be negatively affected by weatherization and

2.6.1(a2) Conditions in the home are acceptable for weatherization to occur

2.6.1(b) Assessments shall address:

2.6.1(b1) Deferral conditions

2.6.1(b2) Occupant safety

2.6.1(b3) Structural and environmental hazards

2.6.1(b4) CAS checks

2.6.1(b5) Electrical evaluation

2.6.2 Deferral Conditions

2.6.2(a) Assessors are expected to consider all reasonable options on behalf of a client before deferral of weatherization services is decided. The client shall be given the opportunity to remedy the deferral condition before the agency shall "walk away," when possible.

2.6.2(b) When weatherizing would make conditions in or on the home worse, weatherization is not feasible and a deferral is required. Deferrals can apply to an entire home or to a limited number of particular, related measures when needed. Deferral conditions apply across CSD's LIHEAP, DOE WAP, and ECIP EHCS programs and are described in Appendix E Health and Safety Requirements, Deferral and Referral Policy.

2.6.2(c) When a deferral is required, agencies shall install feasible measures and, as applicable, refer the client to other agencies or programs in accordance with Appendix E Health and Safety Requirements, Deferral and Referral Policy. Referrals for additional assistance to clients may include the following:

2.6.2(c1) U.S. Farmers Home Administration (FHA) Housing Loan Program

2.6.2(c2) U.S. Department of Housing and Urban Development (HUD)

2.6.2(c3) Department of Housing and Community Development (HCD)

2.6.2(c4) County Department of Aging or Senior Resources

2.6.2(c5) Other similar programs

2.6.3 Occupant Health

2.6.3(a) Assessors must take into account how the occupant's health may affect the feasibility of measures. The following must be considered:

2.6.3(a1) The age and general health of the occupants, especially for more vulnerable populations (very young, disabled, seniors, etc.)

2.6.3(a2) Possible effects of weatherization on the living space, which may include, but are not limited to:

- Effects of shell leakage testing on sensitive persons and animals, especially during times of extreme outdoor temperatures
- Potential danger to children who play in locations where weatherization takes place
- Friable asbestos or presumed asbestos-containing materials within or affecting the living space
- Potential to disturb pre-1978 painted surfaces or locations where pre-1978 painted surfaces are already severely degraded
- Dust and debris from cutting, scraping, sanding, and other activities that must be performed inside the living space that may create dangerous airborne particles or fibers
- Potential effects of infiltration reduction on radon concentrations in the dwelling

2.6.4 Air Quality Assessment

2.6.4(a) In homes, some sources of air pollutants can be chemicals, gases, standing sewage, and living organisms like mold/moisture and pests. Health symptoms from poor air quality may be: irritated eyes, burning in the nose and throat, headaches, fatigue, or even serious long-term conditions such as heart disease or cancer. Individual pollutants at high concentrations, such as carbon monoxide, may even cause death.

2.6.4(b) Based on the severity of conditions found during an assessment, the home may be identified with an IAQ fail and require limited deferral (home is NIM).

2.6.4(c) For more severe conditions, full deferral of the home shall be required, in accordance with Appendix E Health and Safety Requirements, Deferral and Referral Policy.

2.6.4(d) When a condition may be corrected within the scope of the weatherization programs, it is the expectation of CSD that the correction occurs or even that a waiver is sought when necessary. Details about IAQ fails and pollutants are provided in Appendix E Health and Safety Requirements, Environmental Hazards.

2.6.5 Environmental Hazards

2.6.5(a) Assessments shall first include a safety check for potentially hazardous environmental hazard conditions in accordance with Appendix E Health and Safety Requirements, Deferral and Referral Policy. All findings shall be noted on the CSD 540 Dwelling Assessment Form and in the CSD 540A Weatherization Mold/Moisture Assessment and Release Form for moisture or mold conditions, where applicable.

2.6.6 Major Structural Issues

2.6.6(a) During assessment, checks shall be made for structural defects to walls, roof, doors, windows, and outbuildings as detailed in Appendix E Health and Safety Requirements, such as:

2.6.6(a1) Broken glass

2.6.6(a2) Leaking and/or deteriorated roof/roofing

2.6.6(a3) Damaged or severely sagging ceiling surfaces and ceiling joists

2.6.6(a4) Failed or sagging foundations, joists, or flooring

2.6.6(a5) Damaged or deteriorated tub/shower or plumbing

2.6.6(a6) Deteriorated siding or door/window frames

2.6.6(a7) Major HVAC defects that exceed the scope of the program

2.6.6(a8) Potentially dangerous electrical wiring

2.6.6(a9) Insects that may cause structural damage:

- Termites
- Powder post beetles
- Carpenter ants

2.6.7 CAS Checks

2.6.7(a) Assessors are required to perform a pre-CAS test at the time of assessment on all gas appliances that affect the living space. Results must be documented on the CSD 700 Combustion Appliance Safety Inspection Form. (See Appendix A Combustion Appliance Safety Protocol.) Any CAS hazards or CAS fails shall be resolved in accordance with the timeline in Fail Correction Timelines.

2.6.8 Heating and Cooling

2.6.8(a) All repair and replacement services are limited to a dwelling's primary heating and/or cooling appliance (Appendix H Reference Documents, Definitions.) All repairs or replacements to the primary heating and/or cooling source must meet the feasibility requirements in Section 4 Heating and Cooling and the repair/replacement criteria in Appendix E Health and Safety Requirements, Identification of Appliance Issues.

2.6.9 Portable Heating or Cooling

2.6.9(a) Where a heating or cooling source is pending repair or replacement, a dwelling shall be provided with temporary portable device to provide cooling and/or heating in accordance with the policy provided in Section 1 General Installation Guidelines and Appendix E Health and Safety Requirements, Portable Heating and Cooling.

2.6.10 Electrical Safety Evaluation

2.6.10(a) If a substandard electrical system is suspected by an assessor, agencies must have an electrician identify if the existing wiring is properly sized with adequate overcurrent protection to support the use of new or portable appliances.

2.6.10(a1) During the assessment, the assessor shall talk to the client about the home's electrical system (even before providing a temporary source of heating or cooling). The assessor should ask the client questions such as those below:

- Does the home have:
  - Any burned-out receptacles? (Fig. G-3)
  - Problems with blowing fuses/breakers?
  - Appliances that have shorted/burned out?
  - Flickering lights?
  - Aluminum wiring? (Note: Aluminum wiring must be checked by a C-10 contractor before any measure is installed that would add to or change the home's electrical load).
- Are there any areas of the home that the owner/client has rewired him/herself? (Note: Do-it-yourself homeowners and property managers who try to make their own modifications may unknowingly create unsafe conditions.)

FIG. G-3: RECEPTACLE WITH CHARRING

2.6.10(b) During the assessment, the assessor also shall look for:

2.6.10(b1) Frayed insulation and bare wires

2.6.10(b2) Loose connections and unprotected splices

2.6.10(b3) Metal junction boxes that are loose and/or uncovered

2.6.10(b4) Heat-producing devices (HPDs) such as recessed lights, doorbell transformers, etc.

2.6.10(b5) Ungrounded boxes or receptacles where proper grounding is required

2.6.10(b6) Undersized conductors and underrated overcurrent protection (fuses or breakers)

2.6.10(b7) Sagging overhead power lines outdoors

2.6.10(b8) Knob-and-tube wiring. (See Section 1 General Installation Guidelines, Knob-and-Tube (K&T) Wiring Guidelines.)

2.6.10(b9) Receptacles overloaded with multiple adapters (overloading the circuit)

2.6.10(b10) Unprotected surface mounted cable (no raceways)

2.6.10(b11) Taped splices or exposed/loose wiring

2.6.10(b12) Charring around receptacles or sparking light switches (loose connections)

2.6.10(b13) Frequent blown fuses or "popped" breakers of a power or lighting circuit

2.6.10(b14) "Daisy-chained" extension cords from receptacles or light fittings

2.6.10(c) Electrical issue documentation

2.6.10(c1) Electrical issues shall be documented on the CSD 540 Dwelling Assessment Form.

2.6.10(c2) The property owner shall be notified of any unsafe electrical condition that is identified.

2.6.10(c3) When corrective work is within the program scope, a licensed electrician (C-10 electrical contractor) shall be contacted to make the necessary repairs or to provide a "Notice of Survey."

2.6.11 State Historic Preservation Review

2.6.11(a) Assessor/auditors shall determine whether the dwelling meets the criteria for a review as mandated by the State Historic Preservation Office (SHPO).

2.6.11(b) Historic preservation review shall be completed on a dwelling that is:

2.6.11(b1) ≥45 years old

2.6.11(b2) Located within a historic district or

2.6.11(b3) Considered to be of exceptional importance under the National Register Criteria for Evaluation in compliance with 36 CFR 60.4

2.6.11(c) CSD requires assessors/auditors to obtain a third-party documentation source to verify the year that each dwelling was built. Acceptable sources include statements from the county assessor's office, online fee-based verification services, title company documentation, etc.

2.6.11(d) All dwellings that are ≥45 years old must be entered into CSD's historic preservation online (HPO) system and shall include all the measures that are assessed to be installed. The following four measures initiate a formal review:

2.6.11(d1) Section 32 Infiltration Reduction, Doors

2.6.11(d2) Section 32 Infiltration Reduction, Window and SGD Repair

2.6.11(d3) Section 33 Windows and Sliding Glass Doors, Installation Procedure

2.6.11(d4) Section 34 Storm Windows

2.6.11(e) The review must be conducted before any weatherization work commences. If there are changes to the original scope of work and any of the four measures above will be subsequently installed, the information in the HPO database must be updated so that a formal review may be initiated or repeated.

2.6.12 Lead-Safe Weatherization

2.6.12(a) Assessors shall determine whether the dwelling meets the criteria for lead-safe weatherization based on the dwelling age and the other criteria below. The dwelling age must be determined by statements from the county assessor's office, online fee-based verification services, title company documentation, etc.

2.6.12(b) When a home was built before 1978, the home shall be presumed to contain lead-based paint unless the dwelling:

2.6.12(b1) Is certified to be "lead-free" by a California Department of Public Health (CDPH)–certified inspector

2.6.12(b2) Is single-room occupancy (i.e., a studio)

2.6.12(b3) Is "housing for the elderly" (housing reserved for households composed of one or more persons 62 years of age or older) and a child <6 years of age does not live there

2.6.12(b4) Is a "disabled unit" (the household is composed of one or more disabled persons) and a child <6 years of age does not live there

2.6.12(c) When the determination is made that presumed lead-based paint exists, an EPA-certified renovator will be assigned to the dwelling for all aspects of the project, including assessment, client notifications, containment, installation, cleaning work, and inspection and certification practices (Fig. G-4). All activities shall be employed in accordance with Appendix E Health and Safety Requirements, Lead Safety Weatherization (LSW) Policy.

Fig. G-4: Lead-Safe Weatherization

2.6.12(d) When paint will be disturbed, the agency-assigned certified renovator must be on-site during the set-up and clean-up and to conduct the clearance procedure.

2.6.12(e) The CSD 708 Lead-Based Paint Regulatory Compliance Report form shall be completed and kept in the client file.

2.6.13 Measure Assessment

2.6.13(a) CSD does not allow abatement of lead, radon, or other hazardous material; home remodeling; or significant construction projects to be completed within the scope of weatherization.

2.6.13(b) Assessors are required to consider the feasibility criteria and installation requirements for each measure to determine whether each measure is feasible, is mandatory, and will be installed.

2.6.13(c) The minimum number of weatherization measures may be leveraged with other weatherization programs when being installed in conjunction with CSD programs.

2.6.13(d) All leveraged measures used to fulfill the minimum number of required measures must meet CSD installation standards and diagnostics policies.

2.6.13(e) All feasible measures must be identified during assessment and prescribed for installation, with consideration given to the average maximum per dwelling.

2.6.13(f) For each program measure, all assessment findings shall:

2.6.13(f1) Be documented on the assessment form and appropriate diagnostic form, if applicable

2.6.13(f2) Have written justification for measures that are determined to be unfeasible

2.6.13(f3) Indicate for each feasible measure the estimated quantity, type, location, etc., as appropriate

2.6.13(g) The determination of measure feasibility for DOE WAP measures shall be determined in accordance with the DOE–Specific criteria listed in each section of the TRM and Appendix D Energy Audit/Priority List Protocol.

2.6.13(h) The determination of measure feasibility for multi-family whole-building measures shall be determined in accordance with the Multi-Family–Specific criteria listed in each section of the TRM and Appendix F Multi-Family Standards.

2.6.13(i) DOE policies and protocols shall prevail for measures installed using DOE WAP Funding. If the unit is leveraged with LIHEAP, then LIHEAP policies and procedures apply to installation of the leveraged measure(s).

2.7. Prioritization of Measures by an Assessor

2.7.1 In accordance with the Appendix E Health and Safety Requirements:

2.7.1(a) After conducting a CAS check, any CAS hazards and CAS fails shall be resolved in accordance with Appendix A Combustion Appliance Safety Protocol timeline before any other program measures may be installed.

2.7.1(b) If an IAQ fail can be resolved within the program scope, it shall be corrected before infiltration-reduction measures are installed.

2.7.1(c) Electrical issues found during the electrical evaluation that prohibit installation of a measure must be resolved prior to the installation of the affected measure.

2.7.1(d) After correction of the Health & Safety conditions above, the assessor shall prescribe the installation order for all other feasible measures.

2.7.2 The measure installation order shall be dictated by the following protocols (and as required by program):

2.7.2(a) Energy audit for audit-driven measures and climate zone–specific priority lists for DOE priority list measures shall be prioritized in accordance with Appendix D Energy Audit/Priority List Protocol

2.7.2(b) Duct testing and sealing activities as specified by the CSD 706 Duct Leakage Data Sheet form and Appendix B Duct Leakage Testing Protocol

2.7.2(b1) When a home is NIM, no duct testing or sealing shall be conducted until the issue that created the NIM condition is corrected.

2.7.2(c) Shell sealing activities as specified by the CSD 704 Shell Leakage Data Sheet form and Appendix C Shell Leakage Testing Protocol

2.7.2(c1) When required by program policy, home selection and shell leakage testing shall be conducted in accordance with Appendix C Shell Leakage Testing Protocol.

2.7.2(c2) All sealing activities performed shall be implemented in priority order and recorded in the CSD 704 Shell Leakage Data Sheet.

- When a home is NIM, no shell testing or sealing shall be conducted until the issue that created the NIM condition is corrected.

2.7.2(c3) A dwelling with no heat source or cooling source (where the owner refuses installation of those sources) shall not qualify for infiltration-reduction measures.

2.7.2(d) A measure shall not be installed when it does not meet the feasibility requirements in the measure's Technical Resource Manual (TRM) or when it cannot be properly installed due to structural limitations of the dwelling.

2.7.3 Energy Audit Requirements

2.7.3(a) When an energy audit is required or performed (as prescribed in Appendix D Energy Audit/Priority List Protocol), all auditors are required to complete the energy audit utilizing only an audit tool adopted by CSD.

2.7.3(b) For small multi-family buildings with common heating and/or cooling systems or multi-family buildings with ≥25 units, the TREAT audit must be applied to all units.

2.7.3(b1) There must be adequate measures to support the cost of performing a full TREAT audit.

- If no measures are installed, the costs of the TREAT audit are not billable.

2.7.3(b2) The assessor/auditor shall educate the building owner about the terms and process of a TREAT audit.

- If a building owner refuses a measure that qualifies with an SIR ≥1.0, the audit process shall stop, and the entire building will not qualify for weatherization services.

2.8. Programmatic Waivers

2.8.1 Because it is not possible to anticipate and address all potential situations in the program policies, CSD makes available programmatic "waivers" to resolve unusual issues that require evaluation on a case-by-case basis. Waivers shall be:

2.8.1(a) Sought through the CSD Providers' website

2.8.1(b) Accepted or denied in writing from CSD

2.8.1(c) Obtained prior to beginning work (purchasing or installing the measure)

2.8.2 Waivers are required when:

2.8.2(a) Expected measure cost would exceed the measure cost cap

2.8.2(b) The home qualifies for more than the maximum quantity of a measure

2.8.2(c) A time extension is required to resolve a CAS hazard

2.8.2(d) An alternative appliance type is considered essential for occupants or a cost-effective option

2.8.2(e) Other repairs are considered essential to the occupants' health and safety

2.8.3 Should a situation arise that is outside of the scope of any CSD weatherization program and it is not listed in the examples above, a program waiver shall be obtained.

2.9. Required Assessor-Client Education

2.9.1 All client education shall be documented on the CSD 321 Client Education Confirmation of Receipt form and retained in the client file.

2.9.2 All weatherization clients shall be provided with the following educational materials available on the Providers' website:

2.9.2(a) EPA pamphlet: "A Brief Guide to Mold, Moisture, and Your Home"

2.9.2(b) EPA pamphlet: "A Citizen's Guide to Radon"

2.9.2(c) EPA pamphlet: "Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools"

2.9.2(d) CDPH fact sheet: "Asbestos in the Home and Workplace"

2.9.3 Permit-Related Education

2.9.3(a) When a permit will be required by the local jurisdiction, CSD requires that the client receive an explanation of the permitting and inspection process.

2.9.3(b) When the dwelling contains obviously un-permitted work (e.g., questionable construction or installation of additions or appliances, etc.), the assessor shall explain that the building inspector may elect to inspect these additional components and that findings or fines related to this additional examination shall be the responsibility of the property owner.

2.9.4 Hazardous Condition Education

2.9.4(a) For all hazardous conditions, if immediate mitigation of the issue is not possible, the agency must, at a minimum, officially "abandon" the qualifying appliance within 18 hours in accordance with the appliance-specific TRM and Appendix A Combustion Appliance Safety Protocol. In addition, the agency must provide client education about the reason for appliance abandonment.

2.9.5 (DOE only) Field personnel shall provide the client with the following information as documented in the completed CSD 540G Health and Safety Form, including:

2.9.5(a) Potential risks created during weatherization

2.9.5(b) A copy of the completed pre-weatherization screening form

2.9.5(c) Contact information for the Subgrantee point of contact

2.10 The contractor shall provide the client with a description of the benefits that the client can expect to receive as a result of the measures to be installed and any diagnostic tests to be performed in the dwelling.

2.11 The contractor shall also discuss with the client any potential environmental hazards observed, such as mold or moisture issues, potential asbestos material, etc., in accordance with Appendix E Health and Safety Requirements.

3. CREW LEADER AND INSTALLER RESPONSIBILITIES AND POLICIES

3.1. Crew Leader's and Installer's Job Roles

3.1.1 Installation personnel are critical to the success of weatherization in a home. They ensure that:

3.1.1(a) Assessors have accurately determined the feasibility of a measure

3.1.1(b) The home still meets the minimum safety requirements before work is started

3.1.1(c) Workmanship is consistently excellent and safety practices are followed

3.1.1(d) Homes are left in a more energy efficient status than when they entered

3.1.1(e) Clients are satisfied and informed about the measures installed

3.1.2 A summary of the field responsibilities for crew leaders and installers is provided in Table G-4.

TABLE G-4: DOCUMENTS GUIDING CREW LEADER/INSTALLER RESPONSIBILITIES

Crew Leader/Installer Responsibility	Policy Reference
1. Identify safety conditions at the home not documented during the assessment.	Dwelling Assessment Policies General Safety and Measure Installation Practices Appendix E Health and Safety Requirements
2. Review the assessment form and all CAS diagnostic paperwork for: − Correct identification of measures − Completeness and adequate written justifications for measure installation − Proper identification of combustion appliance/safety issues − Documentation of client refusals of measures	Assessment Documentation Appendix E Health and Safety Requirements Appendix A Combustion Appliance Safety Protocol
3. Confirm permits for applicable measures have been obtained when required by the local jurisdiction.	Permit-Related Education Section 1 General Installation Guidelines
4. Perform all Health & Safety corrections, if qualified. If the installers are not licensed and work will be performed by a licensed subcontractor, installers shall confirm that corrections are finalized before any duct or shell leakage work is done.	Installation Timeline Duct Testing and Sealing Shell Sealing (Infiltration-Reduction Measures) Appendix A Combustion Appliance Safety Protocol Appendix E Health and Safety Requirements Individual measure TRM sections
5. Perform duct leakage work and record results in accordance with the CSD 706 Duct Leakage Data Sheet form.	Duct Testing and Sealing CSD 706 Duct Leakage Data Sheet Appendix B Duct Leakage Testing Protocol
6. Perform shell sealing work and record results in accordance with CSD 704 Shell Leakage Data Sheet form.	Shell Sealing (Infiltration-Reduction Measures) CSD 704 Shell Leakage Data Sheet Appendix C Shell Leakage Testing Protocol
7. Based on results of Health & Safety corrections and diagnostic testing, if additional work is identified or has changed from original assessment, confirm all changes to the work scope with the original assessor and document accordingly. Notify the property owner if required.	Appendix E Health and Safety Requirements Appendix A Combustion Appliance Safety Protocol Appendix B Duct Leakage Testing Protocol Appendix C Shell Leakage Testing Protocol
8. Install mandatory measures.	Measure Assessment Prioritization of Measures by an Assessor Lead-Safe Weatherization Individual measure TRM sections

TABLE G-4: DOCUMENTS GUIDING CREW LEADER/INSTALLER RESPONSIBILITIES

Crew Leader/Installer Responsibility	Policy Reference
9. Install mechanical ventilation when mechanical ventilation assessment is required by the program and assessment shows 16 cu. ft. per min. (CFM) or more. Check the flow rate of existing exhaust fans and the installed whole-house mechanical ventilation system.	CSD 540C Whole-Dwelling Ventilation Calculation Worksheet CSD 540D Mechanical Ventilation Assessment Form Section 12 Mechanical Ventilation
10. Install all feasible audit-driven measures as determined by energy audit and DOE priority list measures as determined by climate zone.	Energy Audit Requirements Appendix D Energy Audit/Priority List Protocol
11. Evaluate the home to ensure that all feasible measures are installed and proper clean-up and material recycling practices were followed.	Lead-Safe Weatherization CSD 540 Dwelling Assessment Form Individual measure TRM sections
12. Perform CAS post-testing. Finalize all installation paperwork while on site.	CSD 700 Combustion Appliance Safety Inspection Form Appendix A Combustion Appliance Safety Protocol
13. Confirm the client's level of satisfaction with the work performed.	Required procedure defined by agency's internal policy
14. Finalize the work order, based on the installation results. Transmit the file to the program administration/ inspection team.	Required procedure defined by agency's internal policy

3.2. Installation Timeline

3.2.1 All Health & Safety issues shall be resolved when feasible under the CSD programs before energy conservation measures are installed.

3.2.1(a) Prior to the performance of any heating/cooling service, a qualified technician must perform a diagnostic inspection of the primary heating/cooling appliance to assess operational performance.

3.2.1(b) Health and safety hazards shall be addressed in accordance with Appendix E Health and Safety Requirements.

3.2.1(c) Health & safety measures shall be installed when feasible.

3.2.2 When an energy audit is conducted, installation of all feasible energy conservation measures shall be prescribed by the energy audit and priority list.

3.2.3 When no energy audit is conducted, and after health & safety measures are installed, then duct and shell leakage activities, and insulation measures must be installed when feasible. All other mandatory measures must be installed before any feasible optional measures.

3.2.4 No feasible measure shall be excluded, unless the:

3.2.4(a) Shell leakage and/or pressurized duct diagnostic test indicates that installation of a measure is not necessary;

3.2.4(b) Dwelling already has that measure in place;

3.2.4(c) Measure cannot be properly installed;

3.2.4(d) Client refuses installation (client refusal is to be documented and placed in file);

3.2.4(e) Measure is not cost-effective, as determined by energy audit;

3.2.4(f) Maximum installation dollar limit is reached; or

3.2.4(g) Measure is not needed or required.

3.2.5 General heat waste measures may not be included in an energy audit. When feasible, they may be installed without cost-justification of an SIR.

3.3. General Safety and Measure Installation Practices

3.3.1 Installation personnel shall identify any safety conditions at the home that were not documented during assessment.

3.3.2 Workplace safety guidelines and general safety practices applicable to all measures are in Appendix E Health and Safety Requirements and as regulated by California Occupational Safety and Health Administration (Cal/OSHA). When additional measure-specific safety practices are required, they will be provided in the TRM section for that measure.

3.4. Lead-Safe Weatherization

3.4.1 For dwellings that were constructed pre-1978, lead-based paint will be presumed to be present and lead-safe weatherization practices shall apply. (See Appendix E Health and Safety Requirements.)

3.4.2 In these dwellings, crew leaders and installers are required to follow the directions of the assigned EPA-certified renovator for all work and use appropriate containment and cleaning practices while on the job, including use of PPE.

3.4.3 Installers who are not certified renovators are required to follow the directions of and on-the-job training by the certified renovator during weatherization activities. Installers who are certified renovators must follow the directions of the assigned renovator when not working in the capacity of a renovator.

3.5. Duct Testing and Sealing

3.5.1 All duct system tests shall be conducted in accordance with Appendix B Duct Leakage Test Protocol. All duct leakage readings and sealing activities shall follow the order of and be recorded in the CSD 706 Duct Leakage Data Sheet without exception.

3.5.2 When a home is NIM, no duct testing or sealing shall be conducted until the issue that created the NIM condition is corrected.

3.5.3 For DOE jobs, the feasibility of duct sealing will depend on the Measure SIR and Dwelling SIR. Duct sealing may not be installed unless both of these SIR values ≥1.0. See Appendix D Energy Audit/Priority List Protocol.

3.5.3(a) If duct testing and sealing are feasible but are refused by the client, the home shall be deferred.

3.6. Shell Sealing (Infiltration-Reduction Measures)

3.6.1 Shell leakage testing shall be conducted in accordance with Appendix C Shell Leakage Test Protocol. All leakage readings and shell sealing activities shall be recorded on the CSD 704 Shell Leakage Data Sheet.

3.6.1(a) Note that higher priority sealing as identified by an assessor, or found to be feasible during installation, that is not performed must be justified in writing or sealing work will receive a fail by the inspector.

3.6.1(b) When a home is temporarily NIM to allow correction of a CAS or IAQ issue, no shell testing or sealing shall be conducted until the issue that created the NIM condition is corrected.

3.6.2 All shell sealing work shall be conducted according to the order of activities described in the CSD 704 Shell Leakage Data Sheet.

3.6.2(a) When a dwelling does not have a heat source or a cooling source by client choice, shell sealing/infiltration-reduction measures are not feasible.

3.6.2(b) When a shell leakage test is not required by program, shell sealing is required whenever feasible.

3.6.3 For DOE jobs, the feasibility of shell sealing will depend on the Dwelling SIR. Infiltration-reduction measures must be installed only when the SIR ≥1.0. See Appendix D Energy Audit/Priority List Protocol.

3.6.3(a) If shell testing and sealing are feasible but are refused by the client, the home shall be deferred.

3.7. Required Installer-Client Education

3.7.1 All client education provided by installers shall be documented and kept in the client file.

3.7.2 Installers shall provide clients with specific client education using both verbal and written instructions. Information must be provided in simple, easy-to-understand terms, combining text and pictures.

3.7.3 Required topics shall be:

3.7.3(a) Proper operation and maintenance for all measures installed

3.7.3(b) Maintenance requirements

3.7.3(c) Programming of controls (where applicable)

3.7.3(d) Safety considerations for each measure installed

3.7.3(e) Details specific to each measure as described in the TRM for that measure, when provided

3.7.3(f) Contact information for the installation company that installed the measure

3.7.3(g) All written warranty information

3.7.4 The process of warranty claims shall be explained to the client, including claims to the manufacturer that fall outside of the labor warranty.

3.7.5 All industry inspection/verification certificates shall be provided to the client. Examples, include but are not limited to insulation certificates, Home Energy Rating System (HERS) verifications, etc.

3.7.6 Installers shall advise clients of potentially dangerous household practices, when applicable, including:

3.7.6(a) Fire and explosion dangers of storing items, particularly combustible or volatile chemical materials, in appliance enclosures

3.7.6(b) The purpose, operation, and maintenance (clearing) of vents for air quality, safety, and proper ventilation

3.7.6(c) Potential hazards of using unvented combustion appliances within a living space

4. INSPECTOR RESPONSIBILITIES AND POLICIES

4.1. Inspector Job Role

4.1.1 Inspectors are those agency personnel who conduct post-weatherization inspections to ensure the work quality meets the standards defined in the TRM. Agency personnel who conduct DOE inspections are required to be certified quality control inspectors (QCIs). CSD's own inspectors and third-party representatives are called quality assurance inspectors (QAIs).

4.1.1 (a) All types of inspectors are vital to the success of an agency. They provide the final agency self-check to ensure that:

4.1.1 (a1) Workmanship is consistently excellent and safety practices were followed

4.1.1 (a2) Assessors and installation crews are in sync in their evaluation of a home and are accountable for their work

4.1.1 (a3) Clients are satisfied

4.1.1 (a4) The number of call-backs is minimal

4.1.1 (a5) Agency and subcontractor training needs are identified and supported

4.1.2 A summary of the field responsibilities for inspectors/QCIs is provided in Table G-5.

TABLE G-5: DOCUMENTS GUIDING INSPECTOR RESPONSIBILITIES

Inspector Responsibility	Policy Reference
Safety	
1. Evaluate dwelling conditions to ensure that safety conditions were resolved to the degree required by CSD policy.	Dwelling Assessment Policies Installation Timeline Duct Testing and Sealing Shell Sealing (Infiltration-Reduction Measures) Appendix E Health and Safety Requirements
Assessment Quality	
2. Confirm adequate written justification is provided for unfeasible measures (or deferral, if dwelling was deferred).	Dwelling Assessment Policies CSD 540 Dwelling Assessment Form
3. Confirm that an energy audit and the Priority List were correctly applied.	Energy Audit Requirements Appendix D Energy Audit/Priority List Protocol
4. Ensure proper identification of all CAS issues and successful remedies for fails.	CSD 700 Combustion Appliance Safety Inspection Form Appendix A Combustion Appliance Safety Protocol
5. Ensure required back-up documentation (i.e., photographs and all form documentation) is complete and present in the client file.	Required Forms Required Photographs (Justification Images) Appendix D Energy Audit/Priority List Protocol

TABLE G-5: DOCUMENTS GUIDING INSPECTOR RESPONSIBILITIES

Inspector Responsibility	Policy Reference
6. Seek evidence of proper: − Permitting and final permits − HERS procedure and HERS inspection − Lead-safe/EPA RRP documentation, where required − Documentation of client refusals of measures	Permit-Related Education Section 1 General Installation Guidelines, Permits Appendix B Duct Leakage Testing Protocol, Recordkeeping Lead-Safe Weatherization Appendix E Health and Safety Requirements, Lead Safe Weatherization (LSW) Policy CSD 540 Dwelling Assessment Form Section 1 General Installation Guidelines
Work Quality	
7. Evaluate all measure installations to ensure TRM standards were met.	General Safety and Measure Installation Practices Inspection Timelines Individual measure TRM sections
8. Where mechanical ventilation is required, confirm flow rates for all exhaust fans.	CSD 540C Whole-Dwelling Ventilation Calculation Worksheet Section 12 Mechanical Ventilation
9. Review the refrigerator calculator to determine if the unit was correctly identified and evaluated and if replacement was performed to the TRM requirements.	CSD 540E Single-Family Refrigerator SIR Calculation Worksheet v1.3 Section 23 Refrigerators
10. Inspect all homes that were weatherized or received an ECIP EHCS measure, including measures installed by a subcontractor.	CSD 611 Contractor Post-Weatherization Inspection Report Per CSD contract/policy
11. Initiate a call-back to correct work quality or apply the warranty, if needed.	Call-Backs and Re-Weatherization Policies Crew Leader And Installer Responsibilities and Policies
Diagnostics	
12. Confirm that the dwelling correctly received CAS, duct leakage, and shell leakage testing.	Diagnostic Verifications and Retesting Appendix A Combustion Appliance Safety Protocol Appendix B Duct Leakage Testing Protocol Appendix C Shell Leakage Testing Protocol CSD 704 Shell Leakage Data Sheet CSD 706 Duct Leakage Data Sheet CSD 700 Combustion Appliance Safety Inspection Form
13. Review to ensure correct duct and shell sealing was completed based on assessment decisions.	
14. Perform re-testing of CAS, duct leakage, and shell leakage tests in accordance with Diagnostic Verifications and Retesting.	
15. Compare inspector diagnostic results to assessor/crew results. Determine if additional training is needed for field personnel.	

TABLE G-5: DOCUMENTS GUIDING INSPECTOR RESPONSIBILITIES

Inspector Responsibility	Policy Reference
Other	
16. Evaluate the home to ensure that proper clean-up practices were followed by crews.	CSD 611 Contractor Post-Weatherization Inspection Report Individual measure TRM sections
17. Confirm client satisfaction with the work completed.	Required Inspector-Client Education Required procedure defined by agency's internal policy
18. Complete the CSD 611 Contractor Post-Weatherization Inspection Report, including detailed notes describing reasons for any measure failure.	CSD 611 Contractor Post-Weatherization Inspection Report Individual measure TRM sections
20. Transmit complete client file to program administration/billing team.	Required procedure defined by agency's internal policy
21. Confirm that field equipment is functional and is calibrated according to CSD requirements.	In accordance with equipment manufacturer instructions • Appendix A Combustion Appliance Safety Protocol • Appendix B Duct Leakage Testing Protocol • Appendix C Shell Leakage Testing Protocol
22. Collaborate with CSD's QAI team during inspection visits.	CSD Oversight Per CSD policy

4.2. Inspection Timelines

4.2.1 Agencies are encouraged to complete all post-inspections as quickly as possible following weatherization to ensure that dwelling conditions or occupants do not change. If a hazard or fail condition is discovered by the inspector, agencies must correct the hazard or fail condition in accordance with the Fail Correction Timelines, or as soon as the condition is identified:

4.3. Inspection Expectations

4.3.1 Post-weatherization inspections shall be conducted for the purpose of assessing the quality and completeness of weatherization services, and checking compliance with program policies and procedures. Post-inspections shall:

4.3.1 (a) Include inspection of the dwelling unit to ensure that all identified health and safety hazards, whether pre-existing or resulting from the performance of weatherization services, have been successfully remedied.

4.3.1 (b) Verify that all measures were completely installed in accordance with the TRM;

4.3.1 (c) Identify any feasible measures not installed, as well as unfeasible measures that were installed; and

4.3.1 (d) Confirm that the unit received shell leakage, and duct leakage testing, as applicable.

4.3.1 (e) Verify data inputs into form calculators, to ensure inputs are appropriate (e.g., the CSD 540C Mechanical Ventilation Calculator and CSD 540E Refrigerator Calculator). Where specified by the form, inspector testing may also be required and shall be documented.

4.3.1 (f) In accordance with Appendix D Energy Audit/Priority List Protocol, compare energy audit reports and billed costs.

4.4. Diagnostic Verifications and Retesting

4.4.1 Diagnostic verification requires inspectors to confirm that CAS testing of eligible combustion appliances was performed. The diagnostic verification shall occur at the time of post-inspection for 100% of dwellings with combustion appliances.

4.4.1 (a) Verification shall include inspection of combustion appliances to verify the safe operating condition of combustion appliances within the dwelling residence.

4.4.2 Agency inspectors also will be required to perform re-tests of diagnostic testing (i.e., combustion appliance safety testing, duct leakage testing, and shell leakage testing) on a minimum of 20% of inspected units for LIHEAP jobs and 100% of DOE jobs with combustion appliances.

4.4.2 (a) Re-testing shall consist of a full diagnostic test to be performed by the inspector, as defined by:

4.4.2 (a1) Appendix A Combustion Appliance Safety Protocol

4.4.2 (a2) Appendix B Duct Leakage Testing Protocol

4.4.2 (a3) Appendix C Shell Leakage Testing Protocol

4.4.2 (b) Results from the inspector's test will be compared by the inspector against results obtained by the crew leader or installation technicians in accordance with CSD forms.

4.4.3 Inspector re-testing shall be conducted and documented by the inspector on the appropriate diagnostic forms.

4.4.4 Agency inspectors shall refer field personnel for on-demand remedial training when a consistent pattern of discrepancies is identified.

4.5. QCI Certification

4.5.1 The DOE Guidelines for Home Energy Professionals project is intended to establish a skilled and credentialed workforce. To provide consistent, objective, and thorough inspections, DOE requires that an inspector demonstrates comprehensive knowledge and technical proficiency by passing an accredited written and field certification exam to become a certified QCI.

4.5.2 This certification is required for all inspectors who are performing quality control on DOE dwellings (or are leveraged with DOE funds).

4.5.3 Certified QCIs are required to renew certification in accordance with BPI requirements. (See www.bpi.org.)

4.6. Subcontractor Oversight

4.6.1 Inspectors shall provide program management with adequate information to judge the performance of weatherization measure installation subcontractors and specialty subcontractors.

4.7. CSD Oversight

4.7.1 CSD will use its own QAI team to review and verify that all weatherization work complies with the TRM, including assessments, measure installations, and inspections. QAI inspections shall be performed in accordance with the CSD Inspection Policies and Procedures Manual located on the Providers' website.

4.7.2 An agency ride-along (designated representative) shall accompany the inspector on inspection visits and shall provide transportation and equipment to the inspector. When possible, the ride-along shall make corrections during these inspection visits.

4.7.3 All fails and hazards identified by the CSD or third-party inspector shall follow the timeline for correction identified in Fail Correction Timelines.

4.8. Required Inspector-Client Education

4.8.1 Inspectors shall provide clients with a final opportunity to ask questions related to installed measures, the process, warranties, or how to obtain assistance if a measure fails. Responses must be provided in simple, easy-to-understand terms.

4.8.2 The inspector also shall provide agency/contractor contact information and determine if the client has been satisfied with the services received, the weatherization experience, and other areas of client satisfaction as determined by the agency.

4.8.3 Client education shall be documented and kept in the client file.

H. Reference Documents

Table of Contents

Abbreviations and Acronyms

Acronym/ Abbreviation	Definition
°C	degrees Celsius
°F	degrees Fahrenheit
AAMA	American Architectural Manufacturers Association
ABS	acrylonitrile-butadiene-styrene
AC	air conditioner/conditioning
ACCA	Air Conditioning Contractors of America
ACDD	annual cooling degree days
ACH	air changes per hour
ACM	asbestos-containing materials
ADM	audit-driven measure
AFUE	annual fuel utilization efficiency
AGA	American Gas Association
AHDD	annual heating degree days
AHRI	Air Conditioning, Heating, and Refrigeration Institute
ANSI	American National Standards Institute
ARB	Air Resources Board of California
ARI	Air-Conditioning and Refrigeration Institute
ASGV	automatic gas shut-off valve
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
awg	American wire gauge
BEAR	Bureau of Electronic and Appliance Repair
BEES	Building Energy Efficiency Standards
BEF	ballast efficacy factor
BHMA	Builders Hardware Manufacturers Association
BOCA	Building Officials and Code Administrators
Btu	British thermal unit(s)
Btuh	British thermal units per hour
CABO	Council of American Building Officials
Cal/OSHA	California Occupational Safety and Health Administration
CAS	combustion appliance safety
CASIF	Combustion Appliance Safety Inspection Form
CAZ	combustion appliance zone
CBC	California Building Code
CBM	Certified Ballast Manufacturers

Acronym/ Abbreviation	Definition
CBO	community-based organization
CCR	California Code of Regulations
CDC	Centers for Disease Control and Prevention
CDD	cooling degree days
CDPH	California Department of Public Health
CEC	California Electrical Code/California Energy Commission
CFL	compact fluorescent lamp
CFM	cubic feet per minute
CFM25	cubic feet per minute of air flow at 25 pascals of pressure
CFM50	cubic feet per minute of air flow at 50 pascals of pressure
CFR	Code of Federal Regulations
CMC	California Mechanical Code
CO	carbon monoxide
COP	coefficient of performance
CPC	California Plumbing Code
CPR	cardiopulmonary resuscitation
CPSC	Consumer Products Safety Commission
CRC	California Residential Code
CSA	Canadian Standards Association
CSD	California Department of Community Services and Development
CSLB	Contractors State License Board
cu. ft.	cubic foot (feet)
cu. in.	cubic inch(es)
CVA	combustion (and) ventilation air
CZ	climate zone
DOE	(United States) Department of Energy
DOSH	Division of Occupational Safety and Health
DV	direct vent
ECIP	Energy Crisis Intervention Program
ECM	energy conservation measure
EER	energy efficiency ratio
EHCS	emergency heating and cooling services
EIA	Environmental Information Association
EPA	Environmental Protection Agency
ERV	energy recovery ventilator
ESA	Energy Savings Assistance (Program)
ETL	Edison Testing Laboratories
EUL	Effective Useful Life
FAU	forced air unit

Acronym/ Abbreviation	Definition
FHA	(United States) Farmers Home Administration
fpm	feet per minute
FS	federal specification
FVIR	flammable vapor ignition–resistant
g	gauge
GFCI	ground fault circuit interrupter
GHW	general heat waste
gpf	gallons per flush
gpm	gallons per minute
H&S	health and safety/Health and Safety/Health & Safety
HazCom	Hazard Communication (Program)
HCD	(California Department of) Housing and Community Development
HDD	heating degree days
HDL	house depressurization limit
HEPA	high-efficiency particulate air
HERS	Home Energy Rating System
HET	high-efficiency toilet
HPD	heat-producing device
hr	hour
HRV	heat recovery ventilator
HSPF	heating seasonal performance factor
HSPP	Health & Safety Partnership Program
HUD	(United States Department of) Housing and Urban Development
HUDMHCSS	HUD Manufactured Home Construction and Safety Standards
HVAC	heating, ventilation, and air conditioning
HVACR	heating, ventilation, air conditioning, and refrigeration
Hz	hertz
IAQ	indoor air quality
IBC	International Building Code
ICBO	International Conference of Building Officials
ICC	International Code Council
ID	inside diameter
IDLH	immediately dangerous to life and health
IGU	insulated glazing unit
IIPP	injury and illness prevention program
IRC	International Residential Code
IRM	Infiltration Reduction measure
IWC	inches of water column
K&T	knob-and-tube

Acronym/ Abbreviation	Definition
kBtu	kilo British thermal units
kBtuh	kilo British thermal units per hour
kHz	kilohertz
lb.	pound(s)
LED	light-emitting diode
LHR	limited home repair
li. ft.	linear foot (feet)
LIHEAP	Low Income Home Energy Assistance Program
LIWP	Low Income Weatherization Program
LP	liquid propane
LSH	lead-safe housing
LSW	lead-safe weatherization
LV	leakage value
MaP	Maximum Performance
MER	minor envelope repair
MFD	multi-family dwelling
MH	manufactured housing OR mobile home
MPH	minutes per hour
MS	measure standard
MUD	multi-unit dwelling
MV	mechanical ventilation
MVR	minimum ventilation requirement
NAIMA	North American Insulation Manufacturers Association
NEC	National Electrical Code
NEEA	Northwest Energy Efficiency Alliance
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NFRC	National Fenestration Rating Council
NFVA	net free ventilation area
NIM	(limited to) non-infiltration measures
NOx	nitrogen oxides (NO and NO2)
NWWDA	National Wood Window and Door Association
OC	on center
OD	outside diameter
OEHHA	(California) Office of Environmental Health Hazard Assessment
OLHCHH	(United States Department of Housing and Urban Development) Office of Lead Hazard Control and Health Homes
OSHA	Occupational Safety and Health Administration
P&P	policies and procedures

Acronym/ Abbreviation	Definition
Pa	pascal(s)
PPE	personal protective equipment
ppm	parts per million
psf	pounds per square foot
psi	pounds per square inch
PSM	process safety management
PTAC	packaged terminal air conditioner
PVC	polyvinylchloride
RPP	respirator protection plan
RRP	renovation, repair, and painting
SAR	supply air register
SCBA	self-contained breathing apparatus
SDI	Steel Door Institute
SDS	safety data sheet
SEER	seasonal energy efficiency ratio
SEMKO	Svenska Elektriska Materielkontrollanstalten
SHPO	State Historic Preservation Office
SIR	savings-to-investment ratio
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPF	spray polyurethane foam
sq. ft.	square foot (feet)
sq. in.	square inch(es)
T2 APS	tier 2 advanced power strip
TB	tuberculosis
TPE	thermoplastic elastomer
TPV	temperature and pressure (relief) valve
TRM	technical reference manual
TSV	thermostatic shower valve
UBC	Uniform Building Code
UEF	uniform energy factor
UL	Underwriters Laboratories
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code
UV	ultraviolet
VOC	volatile organic compound
WAP	weatherization assistance program
WIS	Weatherization Installation Standards
Wx	Weatherization
XRF	X-ray fluorescence

Terms and Definitions

Term	Definition
Abandoned appliance	Abandonment of an appliance, and related policies, are described in Appendix A Combustion Appliance Safety Protocol. When prescribed, abandonment shall be completed before any infiltration or non-infiltration measures are installed. An appliance that has been removed from client use by doing the following: • Written permission from the property owner shall be obtained in the CSD 542 Deferral Form for abandonment and commitment to not reattach the appliance. (Note: If the client refuses abandonment, the home shall be restricted in non-infiltration reduction measures). • Remove the flexible gas connector ("gas flex"), and • Cap the appliance line (shut-off) valve, or remove the valve and cap the gas supply line, and • Disconnect electricity to the unit, if applicable and feasible (e.g., power switched off at the breaker or fuse, or the cord unplugged). Removal of the appliance from the premises with client permission may occur at the time of the appliance abandonment or before weatherization is completed. A removed appliance shall be disposed of properly.
Adapters, plumbing type	Threaded fittings designed to fit specialized plumbing threads and diameters associated with some styles of showerheads and faucet aerators. Adapters convert from the specialized connections to standard connections commonly used.
Air changes per hour (ACH)	ACH is the air infiltration rate of a building at natural (atmospheric) pressure. • ACH is the number of times per hour an amount of air equivalent to the entire volume of a building will pass through the shell as infiltration. • If a 4,000–cu. ft. dwelling had infiltration at natural pressure equivalent to 1,000 cu. ft. per hour, the air infiltration rate would be 0.25 ACH (1,000 ÷ 4,000 = 0.25). In other words, during each hour, one-fourth of the air in the dwelling would be replaced (changed) by fresh outdoor air.
Air-free (CO)	A CO measurement taken with a test instrument that calculates the amount of CO ppm without the presence of excess air. The amount of oxygen in the combustion gas is taken into account by adjusting the as-measured CO ppm value to simulate oxygen-free conditions in the combustion gases.

Term	Definition
Appliance line valve (Appliance shut-off valve)	A manual gas shut-off valve installed between the gas supply pipe and the flexible gas connector. It must be located within 6' of the appliance it serves. The flexible gas connector must be completely in the same room as the appliance to which it is connected.
Appliance repairs	Cleaning and replacement of fuel nozzles and jets, replacement of thermocouples, refrigerant, or other component repairs or replacements necessary for safe and efficient operation. Must be accomplished by a technician qualified to perform such work. Also see "Appliance service."
Appliance service	Minor corrective work performed by utility service personnel or qualified technicians, intended to make an appliance operate properly without repair or replacement. Includes cleaning burners and orifices, adjusting air/gas mixture, adjusting manifold gas pressure, or correcting of electrical hazards.
As-measured (CO)	The measured CO ppm from a sample of combustion gases with no regard for the amount of excess air diluting the CO concentration. The test instrument does not perform a calculation to account for oxygen in the combustion gases.
Assessment	The process used to evaluate an eligible dwelling unit for weatherization services offered under the DOE and LIHEAP weatherization programs. The purpose is to determine if the dwelling qualifies for weatherization and, if so, what labor and materials are necessary to weatherize the unit. An assessment shall only be performed by qualified individuals possessing the required skill and training needed to perform assessment activities.
Astragal	The vertical strip that spans the gap between the two meeting edges of double doors (e.g., French doors). The astragal attaches to a stile on one of the doors and provides a surface against which the other door closes and seals.
Attic venting	Screened and/or louvered vents installed to provide attic ventilation (airflow though the attic) in a dwelling. • Low vents typically are eave and soffit vents, but they can also be a roof jack/eyebrow installed low on the roof, or a gable vent installed low on the gable wall. • High vents typically are roof jacks, eyebrow vents, dormer vents, and wind turbines. Minimum NFVA venting requirements are described in Section 40 Attic Ventilation.
Audit	See "Energy audit."

Term	Definition
Audit path	The weatherization approach in which energy conservation measures are included in the work scope based on the results of a site-specific energy audit as specified in Appendix D Energy Audit/Priority List Protocol.
Audit-driven measure (ADM)	A subset of energy conservation measures that require an energy audit. To be installed an ADM must be determined to be cost-effective by having Measure savings-to-investment ratio (SIR) value ≥1.0 and an overall Dwelling SIR of ≥1.0.
Automatic door bottom	An air-sealing device installed at the bottom of a door on the interior. A carrier (with a pliable gasket on the bottom) slides down to contact the floor or threshold when the door is closed, and it slides up to clear the floor/covering when the door is opened. It may be used when a shoe-and-saddle combination is not feasible. (Different from a flip sweep that pivots to move up and down, which is not an approved material.)
Automatic gas shut-off valve (AGSV)	An automatic safety device that is installed on some gas water heaters to protect against overheating by shutting off the gas supply when water in the tank reaches a preset level, typically 210°F. Code requires that a separate pressure relief valve also be installed somewhere in the cold water supply line. An AGSV (such as a Watts-210) may be used on water heaters instead of a temperature and pressure relief valve (TPV). This is done in locations where a gravity drain line to outdoors cannot be installed (e.g., interior locations in multi-family units and in basements). Also see "Temperature and pressure (relief) valve (TPV)."
Backdrafting	The reverse flow of combustion gases down the vent pipe and out the draft hood of a natural draft open combustion gas appliance. Intermittent backdrafting can be caused by wind gusts. Ongoing backdrafting can be the result of a negative pressure in the combustion appliance zone (CAZ) caused by: • Duct system return leaks in the vicinity of the appliance, • Blockage of the vent pipe, and/or • The excessive interference of mechanical systems exhausting air from the structure (e.g., bathroom and utility room exhaust fans, kitchen exhaust fans, clothes dryer, built-in vacuum system, etc.).
BB hole	A hole in a window pane that is less than ¼" in diameter, similar in size to a BB.

Term	Definition
Belly cavity return	Because belly cavity returns are considered a source of catastrophic duct leakage in a mobile home, whenever feasible, an un-ducted belly-cavity return, shall be: • Abandoned, by removing floor registers and filling/ sealing the holes, and • Replaced by a ducted central return. Regular duct testing shall be performed after the belly-cavity return has been replaced with a ducted central return. Note: If it is unfeasible to abandon a belly cavity return, modified duct testing shall be performed. • Isolate the return system from the FAU (e.g., with cardboard and tape at the bottom of the FAU). • Perform a duct test on the supply side of the system, with the Duct Blaster connected to a supply register or attached to the FAU at the supply plenum.
Bellyboard	A protective thin rigid or flexible material, also known as rodent barrier, attached to the bottom of the floor supports (joists) of a mobile home to keep rodents out of the insulation and underfloor area.
Braiding	When multiple separate funding sources are used on one weatherization project to address the different needs within the home, while ensuring each funding source is isolated and tracked independently. This is also referred to as “full measure leveraging”. One funding source is required to be Department of Energy Weatherization Assistance Program (DOE WAP) funds.
British thermal units per hour (Btuh)	A measure of the quantity of energy from fuel that is consumed by the burner of an appliance. • For simplicity, large Btu ratings can be referred to as kBtuh (1,000 Btuh = 1 kBtuh). Thus, the rating of a 90,000 Btuh input furnace can be expressed as 90 kBtuh.
Built-up roof (low-slope)	A low-slope roof that is “built up” with roofing felt laminated in overlapping layers to form a membrane that is 2–4 plies thick. To protect the membrane from sunlight and physical wear, a layer of aggregate (crushed stone or other mineral granules) is embedded in the surface.
Buy-down (Measure buy-down)	A method of measure funding that applies to audit-driven measures when the property owner/landlord of a multi-unit building contributes to the cost of a measure through a financial contribution or with an applied rebate. This optional approach only applies to single-family (2-4 unit buildings only), small multi-family, or large multi-family rental properties, and the buy-down cannot be applied to an owner-occupied unit. Additional requirements apply as specified in Appendix D Energy Audit/Priority List Protocol.

Term	Definition
Call-back	A call-back is when a measure fails (either during inspection or later within the warranty period) that is required to be corrected by an agency. The required warranty periods are defined in each measure. Also see "Go-back."
Carbon monoxide (CO)	A gas produced as a byproduct of the combustion process. CO is toxic to humans and animals because it binds to hemoglobin atoms in the bloodstream in place of oxygen and starves the body of oxygen. CO poisoning can cause a variety of health problems or death.
Catastrophic leakage	Duct or shell leakage that is large and must be documented by photographs, measurements of the gap, calculations, and a written description of the leakage. • In ducts, catastrophic leakage is defined as a condition identified when: − The duct tester is in "open mode" and speed control is at maximum and − Duct pressure no greater than 24 Pascals is achieved ▪ Examples include crushed or disconnected ducts, incomplete duct systems, or visible holes through the duct material that allow the escape of conditioned air. ▪ Duct leak repairs must be made in accordance with Appendix B Duct Leakage Testing Protocol as long as no unresolvable CAS or IAQ fails are present. • In a shell (envelope), catastrophic leakage is defined as a physical gap(s) measuring at least 5 sq. in. of leakage calculated for a single measure location (e.g., a door, a window, etc.). − Shell leak repairs must be made as long as no unresolvable CAS or IAQ fails are present, in accordance with Appendix C Shell Leakage Testing Protocol.
Chandelier	A suspended luminaire (e.g., hanging from ceiling or attached to bottom of a ceiling fan) that incorporates exposed lamps as a decorative element. It is sometimes referred to as "cluster lighting."
Child/children	Member(s) of a household who have not attained their 19th birthday.
Client advisory condition	A non-conforming condition that does not need to be corrected to weatherize or to install infiltration reduction measures. Client advisory conditions are reported to the client and recorded in section D of CSD CASIF Form 702.

Term	Definition
Client education	Verbal and written information provided to the client describing energy-saving behavioral adjustments to decrease the energy consumption of the household. Client education can include, but is not limited to, providing the client with resource information; local agency referral; mold, radon, and lead-safe education; warranty information; advising the client of the benefits of weatherization; and showing the client how to properly operate and maintain the installed weatherization measures.
Climate zone (CZ)	One of the 16 climate zones established by the California Energy Commission that represents a geographic area and has a particular weather pattern. A climate zone is based on energy use, temperature, weather, and other factors that determine the types of building standards that are subject to the Title 24 Energy Efficiency Standards and that determine the energy conservation measures that must be installed in a weatherized dwelling.
Closure system (Duct closure system)	The sum total of components used to secure and seal a duct system joint or seam against air leakage (e.g., pressure-sensitive tape, heat-activated tape, or mastic with fiberglass mesh reinforcement). Closure systems for non-metallic flexible ducts also include one or more drawbands.
Co-funding	When leveraged funds (not owner-contributed funds) are applied to install a measure that does not have a Measure Savings to Investment Ratio (Measure SIR) of 1.0 or greater. One funding source is required to be Department of Energy Weatherization Assistance Program (DOE WAP) funds. Compared to measures using leveraged funds, the DOE WAP investment must result in a Measure SIR of at least 1.0, and the Dwelling SIR must be at least 1.0 (calculated using the DOE WAP total investment only). This is also referred to as “partial measure leveraging”.
Combustion appliance	An appliance that burns fuel. Combustion appliances include those that use natural gas, propane (LP gas), fuel oil, wood, wood pellets, coal, or any other flammable liquid (e.g., kerosene) or combustible material.
Combustion appliance zone (CAZ)	The room or area of a home in which one or more open combustion appliances are located. The area is subject to pressurization or depressurization that can affect proper operation of the appliance(s). • Depressurization (negative pressure) in the CAZ is of greatest concern for natural draft appliances—typically a furnace, water heater, wood burning stove, or fireplace drawing combustion air from the living space.

(Continued on next page.)

Term	Definition
	(Continued on previous page.)
Combustion appliance zone (CAZ)	• The CAZ could be a living room containing a wood burning stove, a kitchen or utility porch containing a water heater, or an appliance enclosure containing a furnace and/or water heater. • Excessive depressurization of the CAZ can cause backdrafting and spillage of CO out of the draft hood and into the living space.
Cost sharing	Dividing the cost of a measure between two funding sources. Cost sharing is not the same as braiding or co-funding. It is used when an SIR is not required. This method of dividing the cost of a measure applies only to Health and Safety, Priority List, and General Heat Waste category measures in the Department of Energy Weatherization Assistance Program (DOE WAP). It requires labor costs to be billed to the DOE WAP and materials costs to be billed to another funding source. This billing option shall not be used for audit-driven measures.
Combustion appliance safety (CAS) fail	A CAS fail is a condition that must be corrected within 20 business days but does not require immediate service (is not a hazard). It is recorded in section D of CSD CASIF Form 702. Infiltration reduction measures must not be installed until all CAS fails are corrected.
Combustion appliance safety (CAS) hazard	A health-threatening condition associated with the operation of a gas- or oil-burning combustion appliance that requires immediate service within 18 hours of identification. No weatherization measures shall be installed until all CAS hazards are corrected.
Combustion ventilation air (CVA)	Adequate CVA in a room or space is a volume of at least 50 cu. ft. per 1,000 Btuh of aggregated input rating of all fuel-burning space and water heating appliances installed in that space. In homes built in 2008 and later, cooking appliances and gas dryers must be added to the CVA calculation. There is insufficient CVA when there is less than 50 cu. ft. per 1,000 Btuh. In this case, additional venting must be added or the condition is considered a CAS fail.
Compact Fluorescent Lighting (CFL)	Energy saving lighting compared with incandescent bulbs. CFLs must be pin-based for CSD programs. LED lighting is the preferred technology currently. See "High-efficacy lighting," "Thread-based CFL," and "Pin-based CFL."
Conditioned space	An area, room, or space that is normally occupied and is heated or cooled for human habitation by any equipment (CMC, §205.0.)

Term	Definition
Conventional home	A site-built dwelling unit (not a factory-built manufactured or mobile home). Note: Single-family dwellings must have a minimum living area of 330 sq. ft. to qualify for weatherization services.
Cover plate gasket	A pre-cut thin foam insulation material designed to fit behind the cover plate of an electrical box (switch or receptacle) to reduce infiltration.
Crawlspace venting	Screened and/or louvered vents installed to provide crawlspace or foundation ventilation (airflow though the crawlspace) in a dwelling. Minimum NFVA venting requirements are described in Section 40 Attic Ventilation and Section 41 Crawlspace Ventilation.
Diagnostic testing	A series of testing protocols performed under the weatherization program that uses specialized tools to assess: • The operating condition of combustion appliances for general safety and carbon monoxide emission levels • Pressurized testing procedure to assess the integrity of building envelope and specific points of air infiltration • Pressurized testing procedure that checks duct systems for leakage and outside air infiltration Diagnostic tests shall only be performed by qualified individuals possessing the required skill and training needed to perform diagnostic testing activities.
Department of Energy Weatherization Assistance Program (DOE WAP)	The U.S. Department of Energy (DOE) provides funds for the Weatherization Assistance Program (WAP). This program is authorized by Title IV of the Energy Conservation and Production Act (P. L. 94 385). The federal regulations for this program are in 10 CFR Part 440. The intent of this program is to increase the energy efficiency of low-income dwellings, reduce the occupant's total residential energy expenditures, and improve their health and safety. For the DOE WAP, allowable measures and materials are defined in the Department of Energy Regulations, 10 CFR Part 440.
Door bottom	Includes the door shoe and sweep. It does not include weatherstripping.
Door shoe	A rigid metal attachment to the bottom of a door that holds a pliable gasket material (sweep), which prevents air leakage under the door.

Term	Definition
Drawband	A device that encircles a duct and mechanically secures the core-to-fitting attachment, i.e., a synthetic duct tie (“zip tie”) or a worm-drive stainless steel clamp. Duct ties are also used to secure/seal flexible duct jackets (vapor barrier) and to secure fiberglass duct wrap.
Dual-use duct system	A duct system used to deliver air from both an evaporative cooler (in summer) and a forced air heating unit (in winter). A vent cover shall not be installed on such a system because the ducts are used to deliver heat and must not be blocked off.
Duct closure system	See “Closure system (Duct closure system).”
Duct insulation	Faced or unfaced insulation material applied to ducting to prevent the transfer of heat through the duct walls. Retrofit duct insulation in weatherization programs is usually fiberglass duct wrap (1"–2" thick) applied to the outside of rigid metal ducting located in an unconditioned space.
Duct system	All ducts, fittings, plenums, and fans assembled to form a continuous passageway for distribution of air (CMC, §206.0).
Dwelling unit	A house, stationary mobile or manufactured home, apartment, group of rooms, or single room occupied as separate living quarters.
Elderly	An individual 60 years of age or older.
Electric baseload measure	A subset of weatherization measures designed specifically to reduce energy consumption in the areas of lighting and electrical appliances. Allowable electric base load measures include LED bulbs, fixtures, night lights, table and floor lamps, microwave ovens, refrigerator repairs/replacements, and electric water heater timers.
Elevator (Shim)	See “Threshold risers and elevators/shims.”
Energy audit	A software analysis tool for assessing a dwelling unit’s energy consumption and determining a list of cost-effective measures for a specific dwelling.
Energy conservation	Energy conservation measures (also known as weatherization measures) include a wide variety of measures installed in or applied to the dwelling to increase the energy efficiency or to reduce the total energy expenditures of the dwelling.
Essential appliance	By CSD definition, an essential combustion appliance is a primary gas heater or primary gas water heater.

Term	Definition
Evaporative cooler	A device (appliance) that cools air through the evaporation of water. Evaporative cooling is especially well suited for climates where the air is hot and humidity is low. • The cabinet of an evaporative cooler has one or more sides equipped with a "pad" (a permeable material, also referred to as "media") through which water will move and air can be pulled. The pad is wetted with water, and the fan inside pulls outside air through the pad. Evaporation of water in the pad lowers the temperature of the moving air, which is then pushed into the building. • The evaporation process adds moisture to the incoming air, which can cause air inside the building to become humid ("sticky") at higher outdoor temperatures. • Clients must be instructed to leave one or more doors, windows, and/or pressure relief passages open whenever the unit is operating, day or night.
Evaporative cooler repairs	Repair or replacement of filter pads, water pump, belt, motor, or other components that will promote efficient operation of the unit.
Factory-built housing	See "Modular home."
Family unit	All persons living together in a single dwelling unit.
Forced air unit (FAU)	The portion of a central heating and/or air conditioning system that contains the air handler (blower section). In a split system, it is the furnace. In a package unit, the combination heating or air conditioning unit may be referred to as the FAU.
Full measure leveraging	See "Braiding."
Gas shut-off valve	See "Automatic gas shut-off valve (AGSV)" and "Appliance line valve (Appliance shut-off valve)."
General heat waste (GHW) measures	A subcategory of weatherization measures within the Department of Energy Weatherization Assistance Program (DOE WAP) designed specifically to improve energy efficiency by reducing general heat and cooling waste within the dwelling. General heat waste measures are defined by contract; in the DOE WAP this subcategory is only applied in the Audit Path. These are capped at a total maximum cost of $250 for all measures in this category.
Go-back	See "Call-back."
Halogen	See "Quartz halogen."

Term	Definition
Hard-wired fixture	A fixture that is: • Mechanically attached to an electrical box with screws and • Electrically connected directly to conductors extending from the electrical box The conductors from the box are attached directly to the fixture's terminals with screws or wire nuts, not plugged into an outlet.
Hazard/hazardous condition	Any condition posing an immediate health and safety threat to the client and/or persons working in the dwelling unit. Hazardous conditions include, but are not limited to CAS hazards, appliance-related hazards, and electrical hazards as defined in the Appendix E Health and Safety Requirements. Also see "Combustion appliance safety (CAS) hazard."
Health and Safety measures	A subset of weatherization measures installed to correct health and safety hazards generated by combustion or electrical appliances and to preserve or improve IAQ. These measures include carbon monoxide alarms, smoke alarms, kitchen exhausts, heating/cooling and water heater repairs and replacements, lead-safe weatherization, and cooking appliance repair and replacements (LIHEAP only).
Heat-activated tape	Metallic duct-sealing tape with an adhesive coating that is activated and cured by the application of heat and pressure. Heat-activated tape is used only to seal joints in rigid fiberglass duct systems.
Heat waste measures	See "General heat waste (GHW) measures."
Heating/air conditioning appliance repairs	See "Appliance repairs."
HEPA (high-efficiency particulate air) filter	A filter that collects 99.97% of all particles greater than 0.3 microns in size. (See "Micron.")
Home Energy Rating System (HERS) rater	A HERS rater, also referred to as a HERS provider, is an entity or individual recognized by the California Energy Commission certified in field and diagnostic testing verifications, necessary for demonstrating compliance with the Building Energy Efficiency Standards (BEES).
High-efficacy lighting	Generally defined as LED or pin-based compact fluorescent lighting, which produce higher amounts of light per watt of electricity than incandescent bulbs. Title 24 specifies that new and replacement lights in bathrooms, garages, laundry rooms, and (outside) front porches generally must provide high-efficacy lighting. (Continued on next page.)

Term	Definition
	(Continued on previous page.)
High-efficacy lighting	High-efficacy compact fluorescent lamp fixtures must be pin-based rather than thread-based; however, LED fixtures may be thread-based to meet the high-efficacy definition.
High-efficiency toilet (HET)	A HET is a WaterSense-labeled toilet that is rated at 1.28 gallons per flush (gpf) or less and has a Maximum Performance (MaP) rating of 350 grams or greater.
House depressurization limit (HDL)	The maximum depressurization (negative pressure) acceptable in a given CAZ as explained in Appendix A Combustion Appliance Safety Protocol. HDL is important with open combustion appliances, especially natural draft (with a draft hood), because they can back-draft and spill CO when negative pressure in the CAZ is too great.
Inaccessible appliance	A combustion appliance that cannot be accessed for CAS testing due to a locked entry or a physical impediment. Examples include: • An appliance in a locked room/enclosure with a key that is not available • An attic-mount furnace in a multi-unit dwelling that requires entry through an inaccessible unit • A floor furnace in a crawlspace with inadequate crawl clearance • A floor furnace that has been covered over by plywood or attached floor covering (e.g., wall-to-wall carpet or vinyl) • A floor or wall furnace that has been turned off and blocked by heavy furniture (e.g., a hutch or cabinet)
Indoor air quality (IAQ) fail	The following air quality contaminants are described in Appendix E Health and Safety Requirements. They may cause serious health issues for clients and their families, and their presence would be considered an IAQ fail unless correctable within the program scope: • Un-vented moisture sources • Significant pet waste and odors • Fumes from stored chemicals/volatile organic compounds • Radon • Asbestos-containing materials • Methane gas • Biological hazards • Combustion byproducts, etc. (Continued on next page.)

Term	Definition
	(Continued on previous page.)
Indoor air quality (IAQ) fail	Infiltration reduction measures shall not be installed when sources of air pollution are present that cannot be corrected. Any IAQ fail must be corrected before infiltration reduction measures may be installed. If a combustion appliance is creating an IAQ or CAS hazard, the appliance shall be checked/serviced by a qualified technician or properly abandoned.
Infiltration reduction measure (IRM)	Measure(s) installed in or applied to dwellings to reduce or stop infiltration (the uncontrolled flow of conditioned air out of the dwelling and outside air into the living space). IRMs are primarily shell sealing measures, but duct sealing is also included (and completed before shell sealing). Additional IRMs are caulking, door repair/replacement, glass replacement, minor envelope repairs, interior vent covers, exterior door weatherstripping, other weatherstripping (access doors, windows, etc.), and window and sliding glass door repair/replacement.
Inoperable appliance	An appliance that does not operate and, therefore, cannot be CAS tested until checked/serviced by a qualified technician. This term is most commonly applied to a gas-burning appliance in which the main burner(s) will not light.
Intake	Includes, but is not limited to, the process of reviewing applicant documentation to verify program eligibility and completing an intake form.
Interim CAS test	A minimum CAS test that must be performed on an open combustion appliance when installation of infiltration reduction measures has begun but is not completed at the end of a workday. This test applies to appliances that draw combustion air from the living space. It is especially important for natural draft units (which have a draft hood) because they can spill CO into the home.
J-Channels	J-channels generally are used around roofing, siding, doors, and windows and are used to keep water away from structural features. J-channels and flashing are specifically needed around windows to prevent moisture intrusion, along the edges of a mobile home roof, or anywhere else that an existing J-channel is damaged, incorrectly installed, or is missing and may be replaced in these conditions in conjunction with the associated measure.
Labeled	See “Listed, listing.”
Lapped seam	The joint formed where two pieces of material (usually sheet metal) are overlapped.

Term	Definition
Lead de minimis (minimum action) California Department of Public Health (CDPH)	The CDPH requires: • In homes built before 1978, lead-safe weatherization (LSW) practices are required by CSD in any home where paint will be disturbed (most strict policy). • Agencies, field personnel and their supervisors, and all subcontractors are required to know and follow lead-safe practices for containment, clean-up, and certification. • Requirements for dealing with lead-based paint are outlined in Appendix E Health and Safety Requirements.
Environmental Protection Agency (EPA)	The EPA Renovation, Repair and Painting (RRP) rule: • Applies to any housing constructed prior to 1978, except housing types inhabited by the elderly or persons with disabilities (unless any child who is less than six years of age resides or is expected to reside in such housing) or any 0-bedroom dwelling. • De minimis (minimum action) levels are activities that will disturb − More than 6 sq. ft. of painted surfaces on the interior of a building (per room) or − more than 20 sq. ft. total on the exterior
Department of Housing and Urban Development (HUD)	The HUD Lead-Safe Housing Rule is required for all HUD public housing and Section 8 rental assistance clients • When HUD's de minimis levels are exceeded, which are: − 2 sq. ft. of paint disturbance per interior room or − 20 sq. ft. on exterior surfaces • When 10% of the surface area of small building components (e.g., trim, window sill, baseboard) is disturbed. When calculating the de minimis level, the entire surface of the component must be included in the computation. See Appendix E Health and Safety Requirements for additional guidance.
Lead-free, certified	Residential property that has been determined by a California Certified Inspector/Risk Assessor Contractor to be free from the presence of lead-based paint
Lead-safe, certified	Residential property in which lead-painted surfaces are intact and/or have been treated with measures to stabilize and eliminate lead-paint hazards and that, as such, poses no immediate threat to the occupants, as determined by a California Certified Inspector/Risk Assessor Contractor.

Term	Definition
Leakage value (LV)	The measured amount of air leakage in a dwelling. The LV is calculated in CFM50 by dividing a dwelling blower door reading by the total square footage of conditioned floor area in a dwelling. The LV is compared with the target value as a measure of successful air sealing work.
Light-emitting diode (LED)	An LED is a semiconductor device that emits visible light when an electric current passes through it.
LED bulb	An LED light bulb is a solid-state lighting device that uses LEDs to produce light. An LED bulb with a standard threaded base may replace existing a screw-in incandescent bulb or CFL. LED bulbs with a pin base are installed in pin-based sockets.
LED night-light	A night-light equipped with an LED light source rather than an incandescent bulb.
Limited home repair (LHR)	• Those repairs that have a direct association with weatherization measures being installed and are necessary for the effective performance or preservation of weatherization materials, or are related to activities that eliminate a Health and Safety hazard that would otherwise prevent weatherization or protects/preserves the installation of a Health and Safety measure. LHR shall not include: • Any other measure or associated incidental repair that has a chargeable line item. • Repairs to the dwelling that are outside of the program scope, including but not limited to handicap ramps, major roof repairs, or correction to structural issues that are a mandatory deferral condition
Listed, listing	Equipment or materials included in a list published by a nationally recognized testing agency (e.g., UL, CSA, ITS, ETL, Warnock Hersey, etc.) that maintains periodic inspection of the production of listed equipment or materials. Listing indicates compliance with nationally recognized standards. Listed appliances and components must be installed in a manner that complies with the terms of the listing (i.e., in accordance with manufacturer's instructions). Other terms include "labeled" and "classified."
Longitudinal joint	A lengthwise joint along a piece of rigid metal duct (e.g., the joint running the full length of a snap-together sheet metal duct).
Low-flow showerhead	Low-flow showerheads have a flow rate less than or equal to 1.8 gpm.

Term	Definition
Low-rise multi-family	Five or more dwelling units with no more than three stories above grade in height. This term is used to define a building type applicable to the Department of Energy Weatherization Assistance Program (DOE WAP) Priority List path.
Luminaire	A complete lighting fixture. A luminaire includes the light source/lamp, the reflector for directing the light, an aperture/opening (with or without a lens/diffuser), the outer shell/housing, an electrical ballast (if required), and connection to a power source.
Mandatory measures	Weatherization measures required by a program to be performed where applicable and feasible. In other words, if a mandatory measure is feasible, it must be installed. (Installation is not optional.)
Manufactured housing	See "Mobile home."
Materials	Materials are those allowable items that are installed in or on the dwelling to promote energy conservation. All materials must conform with the material specifications for the measure installed.
Measure in place	A weatherization measure that already exists, is in serviceable condition, and functions properly—even if not installed in accordance with current installation standards. This makes replacement not feasible unless specifically allowed by CSD.
Micron	A unit of length in the metric system equal to one millionth of a meter. One micron is 0.00003937 inches. A strand of human hair is about 100 microns wide.
Mini-split air conditioner or heat pump	Mini-split units are small heat pumps that condition air in smaller spaces and have no ducts. They are easily installed, and their energy consumption is low compared to central systems. Installation of a mini-split system to replace an existing system requires a program waiver.
Minor envelope repair (MER)	MERs are those infiltration reduction repairs that have a direct association with weatherization measures being installed and are necessary for the: • Effective performance or preservation of weatherization materials, or • To stop infiltration and general heat waste. See Section 32 Infiltration Reduction.

Term	Definition
Mobile home	A mobile or manufactured home is regulated by HUD and is built on a trailer chassis and designed for highway delivery to a permanent location. It can be a single-, double-, or triple-wide home. To receive weatherization services under a CSD program, a mobile home must be a permanent, full-time residential dwelling with a floor area of at least 320 sq. ft. It must be more than 8' in width and more than 40' in length.
Modular home (Factory-built housing)	A modular home is not the same as a mobile home. In California, modular homes are called factory-built housing and are subject to Title 24 and the California Residential Code—not the HUD code. Alteration permits are issued/inspected by the local building department, not HCD. A modular home has framing characteristics similar to a conventional home and is built for permanent installation on a foundation. It is not built on a trailer chassis, it does not have axles, wheels, or a license plate, and it is transported in one or more sections on a dolly or trailer. To receive weatherization services in CSD programs, a modular home must be a permanent, full-time residential dwelling with a floor area of at least 330 sq. ft.
Multi-family	Five or more units in a single building with common or independent heating and/or cooling systems. See "Multi-unit dwelling (MUD)." In a multi-family whole building project, there must be five or more units with common heating and/or cooling.
Multi-family central water heating system	A water heating system that provides hot water for more than one residential unit of a multi-family complex.
Multi-unit dwelling (MUD)	Within local code, a MUD is defined as a residential dwelling structure containing more than one residential unit within a single building or complex. Within CSD's programs, a MUD is defined as a residential dwelling structure containing five or more attached residential units within a single building.
National Fire Protection Association (NFPA) 90B	Standards governing installation of "warm air heating and air conditioning systems" in one- or two-family dwellings and structures not exceeding 25,000 cu. ft. (NFPA 90A applies to larger structures). It provides specifications for the manufacture and installation of rigid metal ductwork and references UL 181 regarding factory-made air ducts (e.g., flexible ducts and rigid fiberglass ducts).
Net free venting area (NFVA)	The net amount of venting (open) area provided by a vent after the blocking effect of mesh and/or louvers has been subtracted from the gross area of the vent opening.

(Continued on next page.)

Term	Definition
	(Continued on previous page.)
Net free venting area (NFVA)	NFVA = [Total area of the opening] minus [Space occupied by screen and/or louvers present in the vent opening]
Non-infiltration measures (NIM)	When a home is NIM, measure installation is limited to non-infiltration measures only. No infiltration reduction measures shall be installed. The most common cause is the presence of a CAS or IAQ fail that cannot be resolved within the weatherization program.
Non-conforming	Usually used in reference to an appliance or component that does not meet code, such as an unlisted or improperly vented gas appliance or a vent pipe with improper termination or inadequate clearance from combustibles.
Non-essential appliance	By CSD definition, a non-essential appliance is a gas appliance—such as a gas clothes dryer, secondary gas heat source, or portable heater—that does not qualify for repair or replacement under the CSD weatherization programs. Also see "Essential appliance."
Non-operable (non-op) appliance	See "Inoperable appliance."
Occupancy sensor	An electronic device that detects the presence of a person in the room/area where a light fixture is located and turns the light on. These are not allowed under the program. Also see "Vacancy sensor."
Operable	Applies to a component (e.g., window or door) or an appliance. The item is considered operable when it properly operates (opens/closes, runs, functions, etc.). Also see "Non-operable (non-op) appliance."
Operable appliance	A heating or cooling appliance that operates when started and provides conditioned air.
Overcurrent protection	An electrical protection device (circuit breaker or fuse) designed to break (disconnect) the circuit if the current exceeds the acceptable rating.
Package terminal air conditioner (PTAC)	A self-contained, non-ducted air conditioning/heating unit that is normally mounted through an outside wall. It is usually larger than a typical wall-mount air conditioner and is most commonly seen in motel rooms and apartments. Installation of a PTAC requires a program waiver because it provides heating and cooling and may conflict with the CSD policy to only provide repair/replacement to a primary source.

Term	Definition
Package unit	An air conditioner, or a combination heating and air conditioning system, contained within one housing unit that is installed outdoors (on the roof or on a slab next to the house). A combination heating and air conditioning unit may also be called a dual pack. Also see "Split system."
Partial measure leveraging	See "Co-funding."
Pascal (Pa)	A unit of pressure equal to 0.004 inches of water column (IWC). • 1 Pa = 0.004 IWC and 1 IWC = 250 Pa • 25 Pa, the pressure typically used for duct leakage testing, is equivalent to 0.1 IWC • 50 Pa, the pressure typically used for shell leakage testing, is equivalent to 0.2 IWC • Conversion formulas are: − [Pa = IWC ¸ 0.004] − [IWC = Pa x 0.004]
Perm	A unit of permeance, which refers to how permeable a material is (i.e., how well moisture will pass though it). Vapor barriers are rated in perms.
Pin-based CFL	Pin-based CFLs plug in rather than screw in. CSD requires that installed high-efficacy lighting fixtures be LED or ENERGY STAR®–certified pin-based CFL fixtures. Also see "High-efficacy lighting" and "Thread-based CFL."
Plenum	An air compartment, chamber or building cavity to which one or more ducts are connected (CMC, §218). • The plenum forms part of either the supply air system or the return air system. • On residential HVAC systems, the supply and return plenums typically are large rectangular boxes/ chambers that connect the FAU to the supply air duct system and the return air system. • FAUs in garages and hallway closets often rest on a platform cavity that constitutes the return plenum, referred to as a platform return. Unlined platform returns are considered to have catastrophic air leakage.
Pressure-sensitive tape	Duct tape with a tacky adhesive coating (butyl, acrylic, etc.) that adheres to a surface with the application of pressure. (Heat is not required.) Duct tapes used in CSD programs must be listed and marked per UL 181A and 181B standards.

Term	Definition
Primary heating/cooling	The main heating and/or cooling appliance for the dwelling. Only the primary heating and/or cooling source (one unit per dwelling) shall be repaired or replaced. It may be provide heating only, cooling only, or heating and cooling. When a home has more than one heating or cooling source, one of the following shall be considered the primary unit: • The appliance that provides conditioned air for the dwelling's primary common living area (i.e., occupied during waking hours) or • The unit providing conditioned air to the largest volume of living space or • The unit with the largest heating/cooling capacity/ output (Btuh or tons) Portable heaters shall not be considered a primary heat source. In a two-story home that has a separate heating and/ or cooling source on each floor, the unit on the ground floor is considered the primary heating and/or cooling source, with the following exceptions: • If the larger capacity/output unit is upstairs, it may be considered the primary unit. • A multi-story home may be constructed with a synchronized system, i.e., one FAU and duct system per story, designed to run concurrently. Repair or replacement of components to the synchronized system may be allowed through approval of a CSD programmatic waiver only.
Priority List	The subset of energy conservation measures determined to be cost-effective by a measure evaluation process. In the DOE WAP, these measures may be installed in a dwelling in the specified climate zone without performing an energy audit.
Priority List path	The weatherization approach in which energy conservation measures included in the work scope are prescribed and installed following a specific order, which is based on the dwelling type and primary heating source. To use the Priority List path, the dwelling must meet specific Department of Energy dwelling characteristics as specified in Appendix D Energy Audit/ Priority List Protocol.

Term	Definition
Programmable thermostat	A thermostat with a clock and internal program that automatically lowers (sets back) or raises (sets up) the room temperature control, so the HVAC unit will turn on only when needed and turn off when not needed for occupant comfort. • A programmable thermostat is usually programmed to lower the room temperature setting by about 10°F in winter (or raise it in summer) when the home is unoccupied and during sleeping hours. • It then brings the HVAC unit back on a short time before occupants return home or get up in the morning.
Qualified technician (for appliance service/repair/replacement)	Qualified persons to work on electric or gas combustion appliances include: • C-20 (HVAC) contractors for furnaces and air conditioners • C-36 (Plumbing) contractor for water heater repair or replacement • C-10 (Electrical) contractor for electrical repairs • D-34 (Specialty) major gas appliance installations (including gas cooking appliances) and ventilating hoods in connection with existing fuel and energy lines that were installed by others. • Utility and propane company gas service technicians for gas appliances.
Quartz halogen	A type of incandescent lamp that is very compact and puts out high-intensity light and heat. Quartz halogen torchiere lamps are very hot and can ignite flammable materials that come close to the lamp (bulb). They also consume much more energy than LED bulbs, so existing quartz halogen torchiere lamps are exchanged for replacement LED torchieres in the CSD Weatherization Program.
Recreational vehicle	A travel trailer, motor home, bus, truck camper or camping trailer that was originally designed as a temporary living quarters and could be self-propelled or mounted on or drawn by another vehicle. A recreational vehicle does not fit the definition of a mobile home or manufactured home. This type of unit is excluded from weatherization services.
Re-weatherization	Once a dwelling has been weatherized and submitted to CSD as a completed unit, any subsequent weatherization services provided to the dwelling are considered re-weatherization. Policies for re-weatherization are determined by funding type and are described in Appendix G Assessor, Crew Leader, Installer, and Inspector Guide.

Term	Definition
Ride-along	A representative of the agency who accompanies a designated third-party or CSD inspector who is performing on-site inspections. CSD requires that, to the extent possible, a ride-along be sufficiently trained to make necessary corrections during inspections, thereby minimizing or eliminating the need for return trips that may inconvenience the client and/or require re-inspection in accordance with Appendix G Assessor, Crew Leader, Installer, and Inspector Guide.
Risers	See "Threshold risers and elevators/shims."
Rodent barrier	See "Bellyboard."
Room air conditioner or cooler	A wall- or window-mount unit (without ducts) that serves a limited portion of the living space, usually just one room or area. The front of the unit is indoors, and the rear of the unit is outdoors. Wall mount units require a hole through the wall the size of the appliance body. Also see "Package terminal air conditioner (PTAC)," which is physically similar (it extends through the wall) but is usually larger; and "Mini-split air conditioner or heat pump," which has an air-handling unit mounted entirely indoors and only a small conduit (with refrigerant lines and wires) extending through the wall to an outdoor unit.
R-value	R-value is a measure of a material's resistance to the movement of heat through it. • Insulation is rated by R-value—the higher the number, the better the insulation's ability to resist heat flow. See Section 37 Attic and Ceiling Insulation, Section 39 Floor Insulation, and Section 38 Wall Insulation.
Sconce	A type of light fixture attached to a wall in such a way that it uses only the wall for support. The light is usually directed upward. It can be a single- or multi-lamp luminaire.
Secondary appliance	When a client has more than one type of appliance served by the program (i.e., heaters, cooling sources, water heaters, refrigerators, or cooking appliances), the assessor shall identify the secondary appliance. Also see "Primary heating/cooling." All repair and replacement services are limited to a dwelling's primary appliance only.
Secondary heating or cooling	Secondary systems (heating or cooling units) are employed only in extreme weather or as backup to the primary system and do not provide conditioned air to the entire dwelling.

Term	Definition
Separate living quarters	Living quarters in which the occupant(s) do not live and eat with any other person(s) in the structure and which have either: • Direct access from the outside of the building or through a common hall or • Complete kitchen facilities for the exclusive use of the occupant(s) The occupant(s) may be a single family, one person living alone, two or more families living together, or any other group of related or unrelated persons who share living arrangements.
Service—Appliance	See "Appliance service."
Shade screen **(Solar shade screen)**	Shade screens utilize a mesh fabric that blocks some of the sun's rays from coming in through the windows while allowing occupants to see out. The screen's ability to block sunlight is its shading coefficient. The smaller the shading coefficient number, the less sunlight (and heat) is allowed into the home. Shade screens installed in the CSD programs must have a shading coefficient in accordance with the measure's material specifications.
Shim	See "Threshold risers and elevators/shims."
Shower arm	The curved pipe, sometimes also called the neck, extending from the shower wall onto which the showerhead is attached.
Single-family dwelling	A detached dwelling structure containing no more than one dwelling unit, or a duplex, triplex, or fourplex. In contrast to this definition, see "Multi-unit dwelling (MUD)."
Site-built dwelling	A conventional single-family dwelling unit built on location, differentiated from manufactured (mobile) homes. Also known as "stick-built."
Smart thermostat	A smart thermostat saves energy by automatically changing the set temperature according to learned behavioral patterns of heating and cooling.
Smoke test	See "Visual draft test."
Solid fuel heating appliance	A combustion appliance that burns solid fuel (wood, wood pellets, or coal). It can be a free-standing stove, fireplace insert, or fireplace.
Solid-state timer	A timer that utilizes an electronic timing mechanism, as opposed to a mechanical or wind-up timer.

Term	Definition
Spillage	In an open combustion natural draft appliance (that has a draft hood), spillage is the unwanted outflow of combustion gases through the draft hood and into the room/space containing the appliance. Spillage occurs when the vent system draft is not adequate to carry combustion gases up through the vent pipe and outdoors. • Brief spillage occurs when combustion first begins in a cold appliance, because cold air in the vent pipe impedes exhaust flow until the system warms up. • Occasional spillage may be caused by wind gusts creating pressure at the vent termination. • Continuous spillage (a CAS hazard) may result when − The vent pipe is blocked by an obstruction or is improperly constructed (too short, too many elbows, improper slope or diameter, etc.) or − There is excessive negative pressure in the appliance location (the CAZ)
Spillage test	A test for spillage performed along the entire draft hood opening. A mirror or the sense of touch (e.g., the back of the hand) is used to detect hot moisture, which will be present if combustion gases are “spilling” out through the draft hood opening. • The mirror will fog up when it comes into contact with hot moisture from spillage. • Spillage will feel hot and moist on the back of the hand.
Split system	A heating and cooling system in which: • The air conditioning evaporator coil (the inside coil) is attached to the furnace, which is located indoors (typically in the garage, attic, basement, or interior closet) and • The condenser unit (with outside coil, compressor, and fan) is installed outdoors, usually on a slab next to the house. Also see “Mini-split air conditioner or heat pump” and “Package unit.”
Storm windows	A fixed or operable window installed on the exterior of a framed-in window to reduce infiltration and heat loss/gain.

Term	Definition
Structural/engineering issues	During assessment, or once weatherization work has begun in a home, if structural or engineering issues are identified or environmental/health and safety hazards are discovered, the issues shall be documented and work must stop until the agency re-obtains property owner permission for the revised scope of work. Examples of these issues include but are not limited to: • Need to relocate an appliance such as a furnace, water heater, or air conditioner. • Feasibility of windows or wall insulation (which may change the appearance of the building exterior). • Need to add an enclosure to house an appliance. • Need to re-size a window or door to meet egress requirements, when required by local jurisdiction. • Need to add ventilation/venting in an unusual location or with an unusual appearance. • Rehabilitation of framing materials around a door or window, that would change the dwelling appearance. • Addition of a whole-house mechanical ventilation system. • HPO measure replacement, which might change the historic value of a dwelling measure. • Notification of the presence (or potential) of a hazardous material (such as vermiculite, asbestos, raw sewage, etc.) which would require clean-up by the owner's certified contractor for weatherization work to continue.
Substandard (construction)	A feature that does not comply with current code or the TRM, or is unsafe or creates an unsafe (or hazardous) condition. Examples include the following: • An unsound ceiling structure that will not support the weight of the installer plus added insulation—such as 2" x 4" joists 48" on center, bowed and sagging joists, or ¼" drywall ceiling. • A sagging roof with improperly sized or spaced rafters. • Wall sheathing that is too thin and is weak or bowed.
Target value	An infiltration reduction goal of no more than 1 cubic foot per minute (CFM) of air leakage per square foot of conditioned floor area in a dwelling.
Temperature and pressure (relief) valve (TPV)	A safety valve required on water heaters that releases water (and thus relieves pressure) if either the temperature or pressure in the tank gets too high. Temperature relief is typically set at 210°F, and pressure relief at 125–150 psi. TPVs are very important because an overheated water heater can explode and cause considerable injury and/or property damage. TPVs must have a gravity drain line to the outdoors. Also see "Automatic gas shut-off valve (AGSV)."

Term	Definition
Thermal shutters	Insulated devices that are designed to cover windows to prevent heat flow through the window. They can keep summer heat out and winter warmth in.
Thermostatic shower valve **Thermostatic showerhead**	A valve installed in a shower that reduces water flow to a trickle when the water temperature reaches a preset level. Manual activation restores water flow. A thermostatic shower valve reduces energy waste when a person turns on the shower to warm up and leaves it unattended beyond the time required for hot water to reach the showerhead. It can be a separate component or built into the showerhead.
Thread-based CFL	A CFL with a standard E27 “Edison” thread (screw) base. Thread-based CFLs are installed in energy efficiency programs to replace standard incandescent bulbs—because, for the equivalent amount of light, CFLs use about 25% of the electricity consumed by the incandescent bulbs they replace. Also see “Pin-based CFL,” "LED bulb," and “High-efficacy lighting.”
Threshold risers and elevators/ shims	Threshold risers are installed on top of the threshold to increase its total height (profile). Elevators and shims are placed underneath the threshold to raise it up so its top surface is higher than the floor. Note: The topmost surface of the threshold or riser must not exceed the maximum height specified in Section 32 Infiltration Reduction.
Tier 2 advanced power strip (T2 APS)	A “smart” power strip equipped with an infrared sensor and/or a motion detector that automatically turns off “switched” outlets when any of the following conditions occurs during a preset period of time: • An infrared remote control signal has not been received • Motion has not been detected within the vicinity of the sensor • The controlling device has been turned off by the user
Torchiere	A tall (5'–6'), free-standing floor lamp with a weighted base and an upward-facing, bowl-shaped reflector on top. In the CSD Weatherization Program, LED torchieres are installed to replace existing fluorescent, halogen, and other incandescent and floor lamps, which consume much more electricity than the LED alternatives. (LIHEAP only. This option is not available as a DOE measure.)

Term	Definition
Transverse joint	The joint formed when two pieces of duct are spliced together (e.g., the joint around the circumference where two round ducts are joined together, or the joint around the perimeter where two rectangular ducts are joined together).
UL Class 0 Duct	Air duct materials having a fire hazard classification of zero (flame spread and smoke developed).
UL Class 1 Duct	Air duct materials having a flame-spread rating of ≤25 without evidence of continued progressive combustion and a smoke-developed rating of ≤50.
UL-classified	Indicates that UL testing was limited to examination of one potential hazard.
UL-labeled	Indicates that a product is either UL Listed or UL Classified. Note that a product can be certified and listed without involving UL. Other accredited laboratories (e.g., CSA, ITS, ETL SEMKO, Warnock Hersey, etc.) can test products and certify compliance with established standards. Thus, such products can be “listed and labeled” without reference to UL. Also see “Listed, listing.”
UL-listed	Indicates that UL testing included examination of all foreseeable hazards.
UL-recognized	Indicates that a component (such as a motor) is approved for use in a UL-listed product (such as an evaporative cooler). The complete cooler is UL Listed, but the tested and approved components used in it are UL-recognized components. Each UL-recognized component is tested to a UL standard applicable to that component, and it is “recognized” for use in a UL-listed product.
Unusually tight construction	Homes with the following construction features: • Walls and ceilings exposed to the outside atmosphere have a continuous water vapor retarder rated 1 perm or less, with all openings sealed; • Weatherstripping on openable windows and doors; and • Caulking or sealants applied to areas such as joints around window and door frames, between sole plates and floors, between wall-ceiling joints, between wall panels, and at plumbing and wiring penetrations and other openings. (CMC, §223.0.)
Useful life	The length of time a weatherization program measure is expected to be useable. Useful life terms are defined in the CSD contracts. Also called "Effective Useful Life" (EUL).

Term	Definition
Vacancy sensor	A vacancy sensor is turned on manually. (It does not come on automatically when a person enters the room.) It keeps the light on when occupancy is detected, and it automatically turns off the circuit after occupancy is no longer detected.
Vanity light (wall-mounted) **Hollywood light**	A multi-lamp fixture made up of a strip of globe lamps, usually mounted next to, above, or around a mirror.
Visual draft test	A draft test performed on an open combustion natural draft appliance utilizing smoke from a smoke pencil, smoke puffer, incense stick, extinguished match, etc. Smoke is applied along the entire draft hood opening. • If smoke is drawn inward, the draft is considered adequate and the appliance passes. • If smoke floats around the draft hood or is pushed away (e.g., due to backdrafting or spillage), the appliance fails the draft test.
Vulnerable populations	Young children (≤5 years old), disabled individuals, and elderly persons (≥60 years old).
Wall- or window-mount air conditioner or cooler	See "Room air conditioner or cooler."
Weatherization program	Weatherization services provided under the CSD-administered DOE, LIHEAP, and ECIP federal contracts. Additional short-term contracts/programs such as LIWP and HET programs may be added upon CSD decision.
Whole-house mechanical ventilation fan	In the ASHRAE 62.2 standard, mechanical ventilation is defined as “the active process of supplying air to or removing air from an indoor space by powered equipment such as motor-driven, ducted fans and blowers (exhaust, supply, or balanced (heat recovery ventilators [HRVs] and energy recovery ventilators [ERVs]), but not by devices such as wind-driven turbine ventilators and mechanically operated windows.”
Window film	A thin, flexible, plastic vinyl material with UV-, infrared-, and/or light-blocking components. It is applied to the interior side of window glass to block some of the sun’s rays from coming into the home. The film’s ability to block sunlight is its shading coefficient. The smaller the shading coefficient number, the less sunlight (and heat) is allowed into the home. Window film installed in the CSD programs must have a shading coefficient in accordance with the measure's material specifications.

California Energy Commission Climate Zones

1. INTRODUCTION

1.1 The California Energy Commission (CEC) climate zones (CZs) and map were created from analyzed weather station data from throughout California. Locations in each of the 16 CZs have temperature data similar to other locations in that CZ.

1.2 It is necessary to know the CZ for certain weather-sensitive measures, such as ceiling insulation, duct testing, and duct repair and sealing.

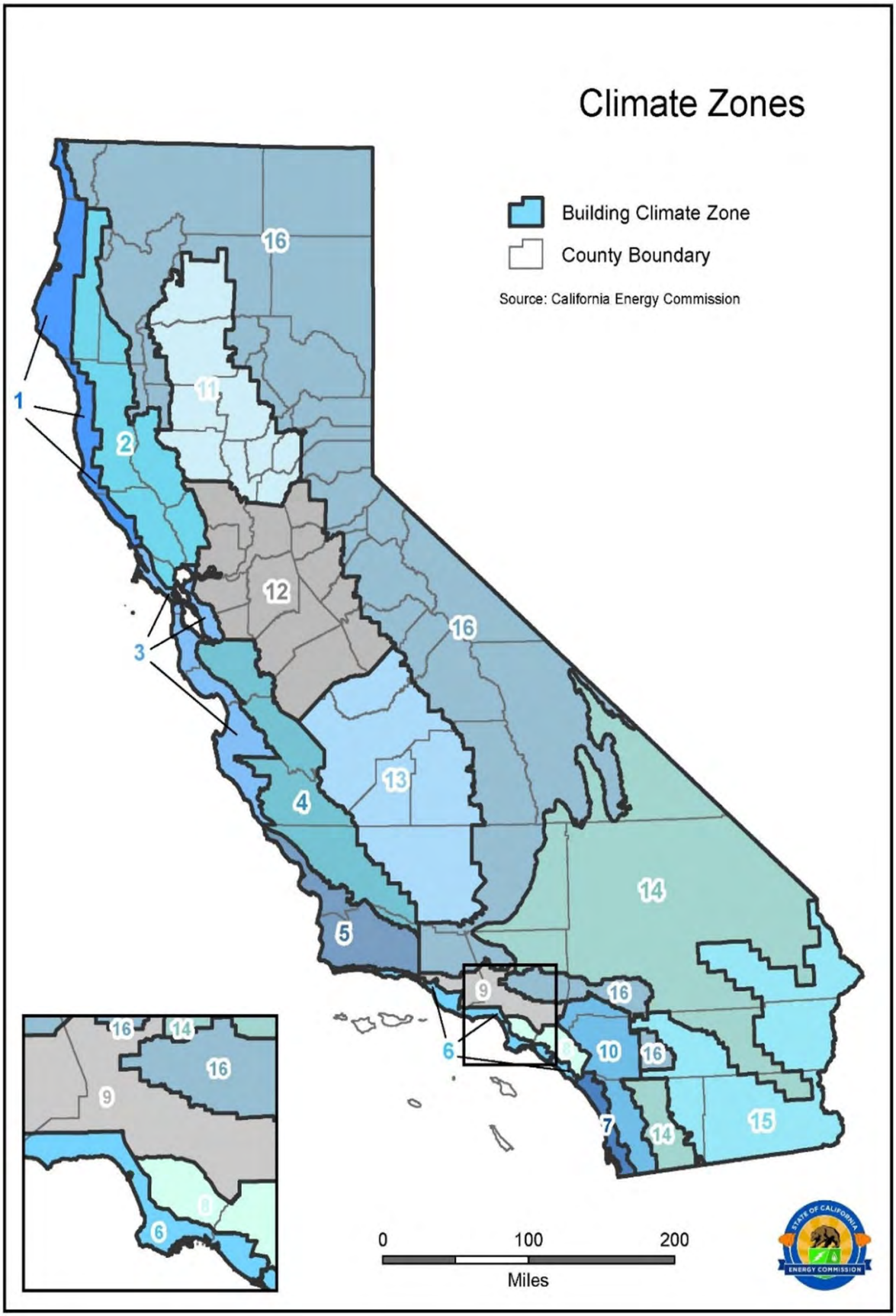
2. CZ MAP

2.1 The CEC CZ map shows where the 16 CZs are located. The CEC has an online CZ search application and interactive map.

2.2 To determine the CZ for a job location, use the California Energy Commission mapping tool here: https://caenergy.maps.arcgis.com/apps/webappviewer/index.html?id=5cfefd9798214bea91cc4fddaa7e643f. Type in the address or name of the nearest city, town, or weather station and the tool will identify the location in the correct climate zone.

2.3 The representative city for each CZ is shown below:

CZ 1: Arcata	CZ 9: Burbank-Glendale
CZ 2: Santa Rosa	CZ 10: Riverside
CZ 3: Oakland	CZ 11: Red Bluff
CZ 4: San Jose	CZ 12: Sacramento
CZ 5: Santa Maria	CZ 13: Fresno
CZ 6: Torrance	CZ 14: Palmdale
CZ 7: San Diego	CZ 15: Palm Springs
CZ 8: Fullerton	CZ 16: Blue Canyon


Climate Zones
Building Climate Zone
County Boundary
Source: California Energy Commission
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100
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Miles