Residential HVAC Tune-Up Evaluation Report

prepared for

Roseville Electric Utility

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1 INTRODUCTION

In August through October of 2018, ERS underwent a study of Roseville Electric's (RE's) residential HVAC tune-up program. The intent of this effort is to provide early feedback on the success of the program by assessing the tune-up reporting by contractors, energy savings based on the actions taken during the tune-up, and testing procedures used by contractors.

2 RESEARCH PLAN

ERS conducted an evaluation and assessment of the HVAC tune-up measure offered by Roseville Electric to its residential customers. This effort represents an industry best practice of obtaining early feedback and identifying areas of improvement. Evaluation is typically conducted after a full year of program implementation; this, however, delays the opportunity to make program improvements based on evaluation findings, often as long as 1 to 2 years after program launch. Conducting early evaluation activities provides more timely feedback to the program administrator, enables continuous program improvement, and increases the realization rate and validity of the reported energy savings.

2.1 Key Questions

For the HVAC tune-up program, the following research questions will guide our efforts:

- Are customers and contractors submitting sufficient documentation to substantiate the work completed?
- Are contractors following the program rules and intent?
- Are contractors following the industry standards for tune-ups?
- Are the prescriptive energy savings estimates that were used to report measure savings a reasonable estimate of the actual energy savings achieved?
- Are customers satisfied with the contractor's performance?

2.2 Work Plan and Methodology

Based on the above, ERS performed the following EM&V activities:

- Using RE-provided data, we created a list of rebates and developed a random sample of rebate applications for review. We selected 30 applications for review.

- We reviewed rebate documentation, including invoices, tune-up result reports, lists of remedial actions implemented, results of refrigerant charge tests, verifications of coil cleaning and filter changes, results of airflow tests, and system sizes.
- Based in part on potential information gaps found in the supporting rebate documentation, ERS developed questions for interviewing contractors who have performed tune-ups. The interviews are used to fill the information gaps, determine contractor understanding of the tune-up process, and identify any contractors who do not follow industry best practices in a way that impacts estimated energy savings.

3 RESULTS

The following section highlights the results of ERS's study, including a summary of the rebate documentation review and interview feedback received from contractors who complete HVAC tune-ups for Roseville Electric customers.

3.1 Document Review

ERS reviewed rebate documentation for 30 applications. The documentation included the rebate form and varying levels of tune-up report and invoice. Each application package was reviewed for completeness based on the rebate form checklist, efficiency actions taken, thoroughness of the tune-up report, and invoiced costs to the customer. ERS estimated the actual energy savings based on documented efficiency actions taken, using the HVAC Tune-Up measure savings from the 2017 POU Technical Reference Manual (2017 POU TRM).

The HVAC Tune-Up rebate form includes a checklist for contractors and customers to adhere to for the application, including:

- Provide paid-in-full invoice
- Provide report of tune-up results and remedial actions taken
- Conduct a refrigerant charge diagnosis and recharge system as needed
- Check and clean evaporator and condenser coils (if feasible and accessible)
- Replace air filters (electrostatic filters may be cleaned)
- Verify adequate airflow
- System size (tons) required

The applications reviewed included tune-ups completed by 13 different contractors, summarized below in Table 1. Four contractors completed a majority (70%) of the projects, with one contractor completing the largest percentage. This was taken into consideration when selecting the contractors to contact for interviews.

Table 1. List of Contractors in Sample

Contractor ID#	Number of Projects	Percent of Projects
Contractor #1	1	3%
Contractor #2	1	3%
Contractor #3	1	3%
Contractor #4	1	3%
Contractor #5	3	10%
Contractor #6	1	3%
Contractor #7	1	3%
Contractor #8	1	3%
Contractor #9	1	3%
Contractor #10	3	10%
Contractor #11	10	33%
Contractor #12	5	17%
Contractor #13	1	3%
Total	**30**	**100%**

HVAC unit sizes in the application sample varied from 2 to 5 tons, with most of the units falling between 3 and 4 tons. Table 2 summarizes the unit size distribution in the sample. The unit size is one of the required pieces of information on the rebate form. However, two of the applications in the sample did not list the unit size in the application form. ERS obtained the unit sizes for these two applications from the model number of the unit.

Table 2. HVAC Unit Size Summary

Unit Size, Tons	Number of Projects	Percent of Projects
2	1	3%
2.5	2	7%
3	8	27%
3.5	6	20%
4	9	30%
5	4	13%
Total	**30**	**100%**

ERS found that the contractors submitted various levels of detail with the supplied documentation of tune-up results and actions taken. This ranged from brief notes on the invoice for the customer to detailed test-in/test-out reports of the tune-up. Figure 1, below, shows the percentage of projects in the sample that did or did not include an adequate tune-up report of the results and actions taken. ERS considered inadequate tune-up report as one that did not

document a test-in/test-out procedure and did not include at least a discussion of measurements performance to determine performance of the unit.

Figure 1. Applications with Tune-Up Reports

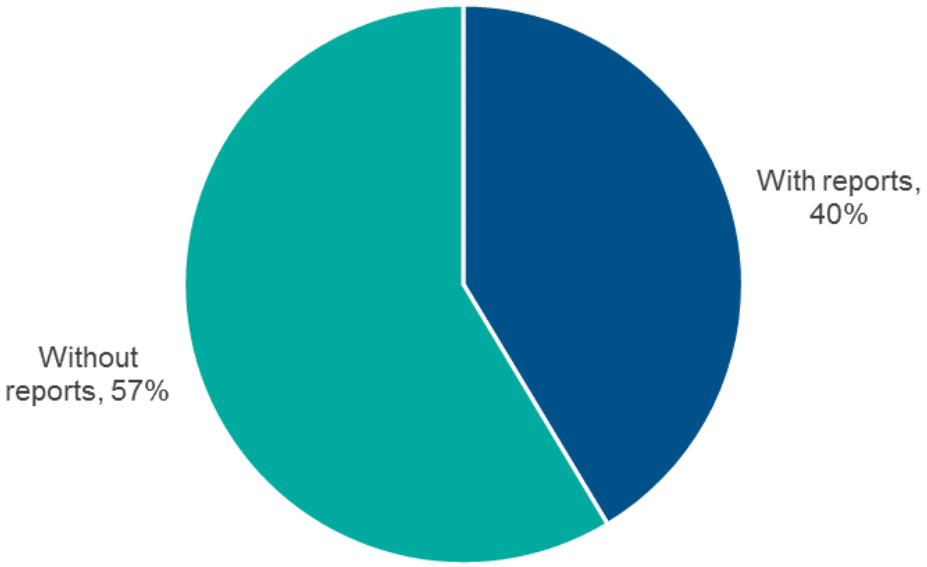


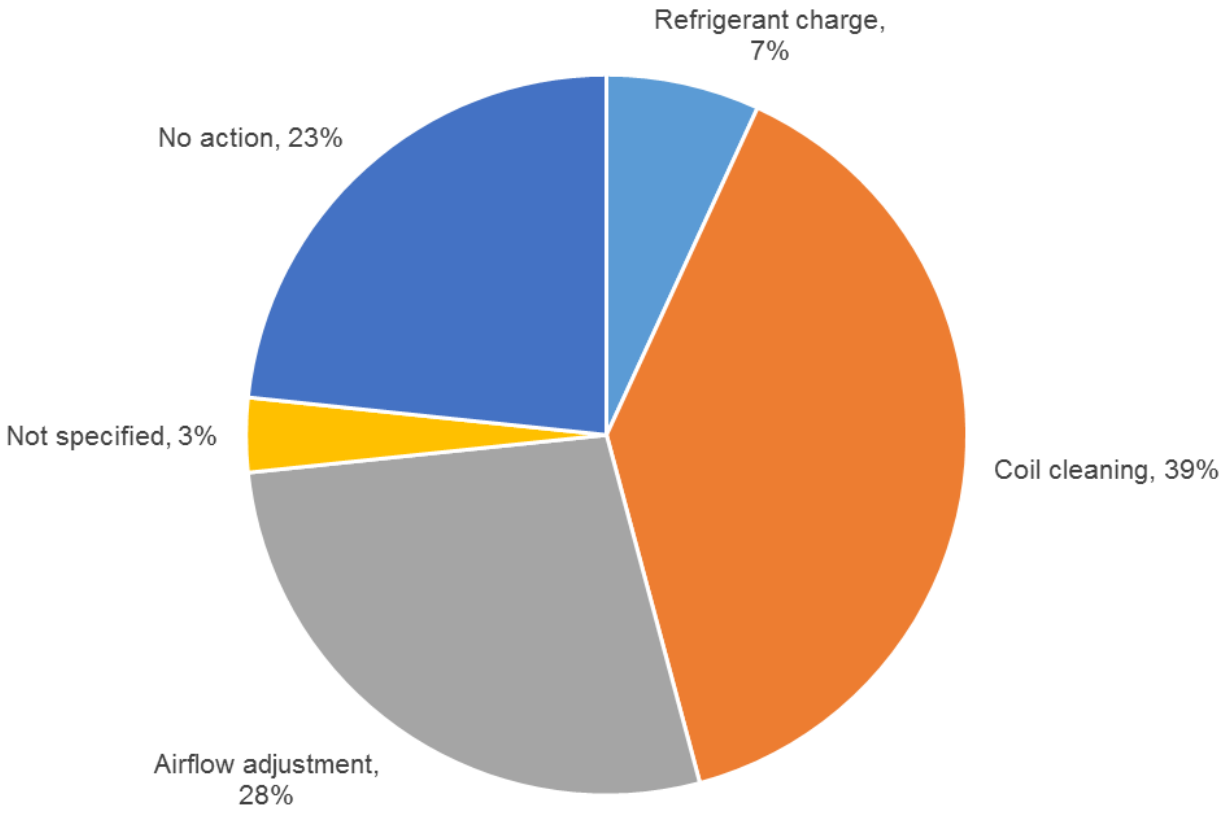
Table 3 summarizes the average cost charged to a customer for a tune-up. This cost varied by contractor and services performed. The amount charged did not always correlate with the estimated energy savings achieved by a tune-up.

Table 3. Average Invoiced Costs to Customers

Contractor ID#	Average Price Billed to Customer
Contractor #1	$59
Contractor #2	$70
Contractor #3	$274
Contractor #4	$59
Contractor #5	$153
Contractor #6	$150
Contractor #7	$75
Contractor #8	$359
Contractor #9	$75
Contractor #10	$142
Contractor #11	$184
Contractor #12	$128
Contractor #13	$78
Average	**$139**

ERS identified the specific efficiency actions performance for each application. Figure 2 summarizes the actions taken in the sample.

Figure 2. Energy Savings Actions



The energy savings specific to the actions taken were estimated using the documented measure savings for HVAC tune-up actions from Section 9.5 of the 20127 POU TRM. Table 4, below, summarizes the unit energy savings from the TRM for climate zone 11.

Table 4. HVAC Tune-Up Unit Energy Savings

Refrigerant Charge Savings		
Energy savings	97	kWh/Ton
Peak demand reduction	0.135	kW/Ton
Coil Cleaning Savings		
Evaporator Coil		
Energy savings	12	kWh/Ton
Peak demand reduction	0.017	kW/Ton
Condenser Coil		
Energy savings	6	kWh/Ton
Peak demand reduction	0.008	kW/Ton
Total Savings (Evap+Cond)		
Energy savings	18	kWh/Ton
Peak demand reduction	0.025	kW/Ton
Airflow Adjustment Savings		
Energy savings	6.15	kWh/Ton
Peak demand reduction	0.008	kW/Ton

Table 5 summarizes the number of times each energy savings action was performed in the sample applications and the total energy savings associated with the action.

Table 5. Occurrence of Each Tune-Up Savings Action

Efficiency Action	Number of Actions in Sample	Energy Savings, kWh
Refrigerant charge	3	1,019
Coil cleaning	17	477
Airflow adjustment	12	246
Total	**32**	**1,742**

A review of the savings recorded in the RE program database appears to indicate that the total potential savings for all three measures was used for each application. However, the efficiency action taken varies for each tune-up service provided. Table 6 provides a comparison of the database-recorded savings versus the savings for each measure that is clearly identified in the contractor's report.

Table 6. Energy Savings Summary

Contractor ID	Number of Projects	Recorded Energy Savings, kWh	Energy Savings Based on Actions Taken, kWh	Percent of Recorded Savings
Contractor #1	1	606	90	15%
Contractor #2	1	606	0	0%
Contractor #3	1	363	36	10%
Contractor #4	1	485	72	15%
Contractor #5	3	1,333	407	31%
Contractor #6	1	485	388	80%
Contractor #7	1	485	0	0%
Contractor #8	1	363	0	0%
Contractor #9	1	606	30	5%
Contractor #10	3	1,030	18	2%
Contractor #11	10	4,422	597	14%
Contractor #12	5	2,060	103	5%
Contractor #13	1	606	0	0%
Total	**30**	**13,448**	**1,742**	**13%**

Additionally, Table 7 looks at the difference in energy savings per actions taken in a given project. This shows that the energy savings for projects that completed a refrigerant charge more closely matched the recorded energy savings. This is because the refrigerant charge measure has a larger savings factor of 97 kWh/Ton, which is 5 to 16 times greater savings than the other HVAC tune-up measures.

Table 7. Energy Savings Summary by Action Taken

Efficiency Actions	Number of Projects	Recorded Savings, kWh	Energy Savings Based on Actions Taken, kWh	Percent of Recorded Savings
None	8	3,513	0	0%
Airflow adjustment	4	1,636	83	5%
Condenser coil cleaning	5	2,362	117	5%
Condenser coil cleaning, airflow adjustment	8	3,574	322	9%
Evaporator/condenser coil cleaning, airflow adjustment	2	1,090	162	15%
Refrigerant charge	1	485	388	80%
Refrigerant charge, condenser coil cleaning	2	787	670	85%
Total	**30**	**13,448**	**1,742**	**13%**

3.2 Contractor Interviews

This section provides a summary of ERS's interviews with three contractors who participated in the HVAC tune-up program. We interviewed service managers from each contractor's firm that were familiar with the program. The interviews were in a conversational style format, which offered the service managers an opportunity to express their thoughts and opinions about the program. We sought to discover what standards or guidelines, if any, they followed in conducting HVAC tune-up type services.

We attempted to interview four contractors. The contractors selected were based on quantity of tunes-up delivered and the comprehensiveness (or lack thereof) of the tune-up report. We completed three interviews; the key contact for one contractor was not available (on vacation).

The following subsections present the key takeaways from each contractor interviewed.

3.2.1 Interview with Contractor #11

- Their service staff use ACCA standards/guidelines[1] whenever possible.
- Their testing process specifically seeks to determine and address the thermal energy delivered to the space by the unit before and after tune-up.
- They offer the customer a series of solutions. Sometimes the customer will proceed with necessary changes, but sometimes they do not.

It should be noted that based on document review, we found that Contractor #11 had the most detailed and clear example of a test-in/test-out diagnostics report. Their reports showed the measurements and the results of the tune-up.

3.2.2 Interview with Contractor #12

- The contractor is very dissatisfied with the RE program.
  - They feel like they were left out of the discussion when the rebate requirements were being planned. They were not consulted about the program or what would be considered realistic requirements.
  - They got the impression that a few contractors were given an unfair advantage and knew about the program details before they did.
- They recommend that Roseville Electric involve more contractors in meetings and planning before launching the program.

[1] Air Conditioning Contractors of America (ACCA) publishes technical guidelines and standards covering maintenance checklists (Standard 4), load calculation (Manual J), air distribution (Manual T), equipment selection (Manual S), duct size calculation (Manual D), and testing (Manual B).

- They consider the extra labor and expenses involved in the diagnostics beyond maintenance to be up-selling, which they do not like to do.
- They tend to not deploy gauges for diagnostics on every customer's system, due to cross-contamination issues and refrigerant leakage.
- They believe that a lot of customers (particularly older customers) were taken advantage of by contractors up-selling services that were not needed.

3.2.3 Interview with Contractor #5

- The contractor will aid customers with a rebate, but it is up to the customer to submit.
- They use a testing process form, which acts as a checklist for HVAC maintenance calls as well as for tune-ups.
- They recommend Roseville Electric set up specific guidelines for HVAC tune-ups.
- Currently they find that a full test-in/test-out call is outside of scope for maintenance calls.
- They believe that the rebate is not large enough to convince a customer to pay for the necessary improvements required to improve efficiency.
  - To illustrate their point, they referenced the PG&E AC Quality Care[2] program, which offers a base rebate of $40 for the initial ACCA Standard 4[3] HVAC System Assessment, as well as rebates for specific actions performed. For example, PG&E offers a $50 rebate for refrigerant charge and a $70 rebate for efficient fan delay.
  - In addition, this stepped approach helps them to market the program. They note that their customers do not want to pay for the possibility of energy savings.
  - They believe customers would be motivated by a rebate in the range of 30%–50% of the full test cost.
- They recommend that Roseville Electric engage in program marketing campaigns, such as radio ads, leaflets, mailers, etc.
- They had difficulties with program timing. They thought it would be easier if they could start completing rebate work earlier in the season.

3.3 Key Findings

Based on our rebate application review and our interviews with program contractors, we offer the following key findings:

- Tune-up reports submitted by contractors were inconsistent in quality and content.

[2] PG&E AC Quality Care rebate application form included in Appendix B.
[3] ACCA Standard 4 is a high-level residential HVAC maintenance checklist; this is not a tune-up specific guideline.

- About 43% of the reports were little more than notes on an invoice and did not adequately describe what was completed during the tune-up (for example, see Contractor #10 reports). Other reports, however, were very detailed and clearly showed what was done, the measurements taken, and the result of the actions (for example, see Contractor #11 reports).

- Two of the contractors interviewed specifically pointed out their use of ACCA Standard 4 and other ACCA standards and guidelines for test procedures. It is worth pointing out that the ACCA Standard 4 does not specify what a tune-up service is but offers a checklist of maintenance steps to be taken.
- The database-recorded savings are based on the three measures documented in the POU TRM. However, the tune-up reports either do not clearly document that these measure improvements were made, or they indicate that the improvements were not needed. If the savings are limited to where the reported clearly identifies improvements were made, the resulting savings are much lower than the recorded savings.
- Contractors appear willing to provide constructive feedback and recommendations for improving the tune-up program.

4 Conclusion and Recommendations

The HVAC tune-up program would benefit from a standardized reporting form. The form would create consistency between contractors on the level of detail provided and provide proof for claiming savings based on improvements made. Appendix A provides an example of an HVAC tune-up checklist form from SCE's A/C tune-up program. Appendix B provides the rebate application form and report guideline from PG&E's AC Quality Care program.

We recommend bringing more contractors into the conversation earlier during the program planning phase. This way RE can address the concerns from contractors and get their input.

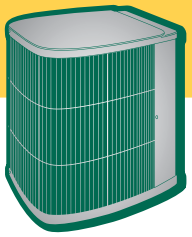
Lastly, we recommend reporting energy savings based on the specific actions performed during each tune-up. Currently, Roseville Electric can report savings for three tune-up measures. The savings should be claimed only when those measures are implemented and documented in the tune-up report.

Appendix A

SCE A/C Tune-Up Application/Checklist Form

SOUTHERN CALIFORNIA EDISON®
An EDISON INTERNATIONAL® Company

A/C Tune-Up Application/Checklist



☐ **BASIC TUNE-UP** **$50 Rebate**

☐ **ADVANCED TUNE-UP** **$150 Rebate**

Customer Information (must be completed)

Customer Name: _____
Address: _____
City, State, Zip: _____
Phone Number: _____
Service Account Number: _____
Service Date: _____

Contractor Information (must be completed)

Company: _____
Service Technician (full name): _____
Phone Number: _____
Address: _____
City, State, Zip: _____
C-20 License Number: _____

TO BE COMPLETED BY A SERVICE TECHNICIAN.

Unit Information (Include additional form if more than one unit serviced)

Model:_____ Size:_____ Age (if known):_____ Serial Number:_____

Systems Checklist required for Basic Tune-Up

TXV: Y ❑ N ❑

Clean or replace air filters: Y ❑ N ❑

Clean & inspect condenser coil: Y ❑ N ❑

Ambient Temp:_____ Condenser Saturation Temp:_____

Clean & inspect condensate drain: Y ❑ N ❑

Check thermostat operation: Y ❑ N ❑

Inspect for proper fuse size & type: Amps_____

Clean, inspect & lubricate condenser coil fan motor: Y ❑ N ❑

Clean, inspect & lubricate evaporator coil blower motor: Y ❑ N ❑

Clean & inspect evaporator coil (if accessible): Y ❑ N ❑

Inspect electrical wiring & tighten terminals/connectors: Y ❑ N ❑

Inspect refrigerant piping for damage or leaks: Y ❑ N ❑

Check for sequence of operation in cooling mode: Y ❑ N ❑

Inspect, clean & straighten any bent fins: Y ❑ N ❑

Condenser FAN FLA:_____ Actual FLA:_____

Check unit input voltage and current: Nameplate volts:_____ Actual volts:_____

Nameplate compressor RLA:_____ Actual RLA:_____

Additional Operating Conditions required for Advanced Tune-Up

Evaporator Entering Air Dry Bulb:_____ Evaporator Leaving Dry Bulb:_____ Suction Line Temp:_____

Evaporator Entering Air Wet Bulb:_____ Evaporator Saturation Temp:_____ Liquid Line Temp:_____

Condenser Entering Air Dry Bulb:_____

Additional Systems Checklist required for Advanced Tune-Up

Check unit refrigeration pressures, temperatures and refrigerant charge[1]: Required Subcooling _____

Inspect duct for system air leaks: Y ❑ N ❑

Duct Leakage[2]: Pre-Test _____ cfm Post-Test _____ cfm

Check refrigerant system for acid/moisture: Y ❑ N ❑

Check system airflow[3]: _____ cfm estimated ❑ measured ❑

1. Check refrigerant charge using the superheat method (non-TXV systems) or the subcooling method (TXV systems). For superheat method, charge to within ± 5°F of the OEM recommended charge. For the subcooling method, charge to within ± 3°F of the the OEM recommended charge.

2. Total duct leakage is measured using a duct pressurization test (e.g. Duct Blaster®) at 25 Pa. Ducts should be sealed to result in a 50% improvement or less than 20% total leakage.

3. Airflow across the coil is typically 350 to 450 cfm per ton. Airflow can be measured directly using a Flow Grid, the Anemometer Traversing Method or estimated using the temperature split method.

MUST INCLUDE COPY OF CONTRACTOR'S INVOICE.

Signatures

Technician Signature (Required):_____ Date:_____

Customer Signature (Required):_____ Date:_____

Mail to: Southern California Edison A/C Tune-Up PO Box 800 Rosemead, CA 91770 Phone 800-369-3652

*Must be a current Southern California Edison single-family residential or small business (less than 200 kW) customer. Work must be performed between April 1, 2008 and July 31, 2008. Applications must be postmarked no later than August 30, 2008. Limit two (2) rebates per residential service account. See next page for complete terms and conditions or visit www.sce.com/tuneup. This program is funded by California utility ratepayers and administered by SCE under the auspices of the California Public Utilities Commission. Funding for this program is limited and is available on a first-come, first-served basis until allocated funds are exhausted, or July 31, 2008, whichever comes first. This program may be modified or terminated without prior notice. Verification of eligibility may be required. Rebate will be delivered in the form of a credit to your monthly billing statement. Please allow six to eight weeks for this adjustment to be reflected.

WEB RES

Terms and Conditions

By submitting the 2008 A/C Tune-Up Program Application ("Application"), I understand and agree to the following:

1. To be eligible for the rebate: (a) I must be a Southern California Edison customer on a residential, GS-1 or GS-2 rate, and (b) the service(s) I have completed must (i) qualify for the rebate, (ii) be performed at a single-family residential dwelling, or (iii) at a business less than 200 kW, fully constructed and occupied, within SCE's service area. I understand I must complete and submit an Application for each service at each address where a qualifying service has been performed. For small business customers, the program is limited to the building owner or the entity responsible for purchasing and maintaining the air conditioning. Tenants who wish to participate must have the building owner's permission.
2. The A/C Tune-Up Program term is April 1, 2008 through July 31, 2008, yet may end sooner if allocated funds are depleted. Any service(s) performed prior to April 1, 2008 or after July 31, 2008 will not qualify for a rebate. Limit two (2) rebates per residential service account.
3. Funds are limited. Applications are accepted on a first-come, first-served basis. The A/C Tune-Up Program may be modified or terminated without prior notice. In the event that rebate amounts change, the service date will be used to determine eligibility and the Application postmark date will be used to determine rebate amount, if any.
4. A signed and dated Application and a copy of the contractor's invoice must be sent to Southern California Edison A/C-Tune-Up, PO Box 800, Rosemead, CA 91770 and postmarked no later than August 30, 2008, to be considered eligible for a rebate. After SCE receives a submitted Application, determines that it is complete and accurate and approves it for payment, a bill credit (Policy Adjustment) will appear on the customers' SCE monthly bill statement within six to eight weeks at the address on record for the service account. SCE reserves the right to select any Application for verification, or reject any incomplete Application(s). If an Application is selected for verification, additional time may be required before the bill credit (Policy Adjustment) is applied.
5. I will allow, if requested, SCE's and/or the California Public Utilities Commission's (CPUC) representative(s) reasonable access to my home or business to verify completion of the qualifying service I have purchased, prior to payment of a rebate. I understand that a rebate will not be paid if I refuse to participate in any required verification. I understand that if I refuse to participate in or fail any required verification after receiving a rebate, I may be required to repay to SCE the amount of any rebate received. The verification of service must be scheduled within 30 days of customer contact by SCE. I understand that SCE may contact the qualifying service provider to verify service performed and may provide my name and/or address to complete this verification.
6. The qualifying service(s) must be performed by a company licensed and able to perform air conditioning maintenance services as evidenced by a valid California C-20 contractor's license. License status can be confirmed at www.clsb.ca.gov. I understand that I cannot receive a rebate for the same product from more than one California investor-owned utility or third party energy efficiency program offering rebates, financing or other incentives funded with CPUC Public Goods Charge funds.
7. I agree that the selection of qualifying service(s), selection of licensed contractor(s) and purchase of the qualifying service(s) referenced in this Application are my sole responsibility, and the provider of these services is not an agent or representative of SCE.
8. I understand that SCE makes no representations regarding contractors, materials or workmanship. I ALSO UNDERSTAND THAT SCE MAKES NO WARRANTY WHETHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR ANY PARTICULAR PURPOSE, USE OR APPLICATION OF THE PRODUCTS.
9. I agree that SCE has no liability whatsoever concerning (1) the quality, safety and/or installation of the service(s), including their fitness for any purpose, (2) the estimated energy savings of the services, (3) the workmanship of any third parties, or (4) any other matter with respect to the 2008 A/C Tune-Up Program. I waive any and all claims against SCE, its parent companies, affiliates companies, directors, officers, employees or agents, arising out of activities conducted by or on behalf of SCE in connection with my Application for any rebate(s) under the 2008 A/C Tune-Up Program. Without limiting the generality of the foregoing, none of such parties shall be liable hereunder for any type of damages, whether direct or indirect, incidental, consequential, exemplary, reliance, punitive or special damages, including damages for loss of use, regardless of the form of action, whether in contract, indemnity, warranty, strict liability or tort, including negligence of any kind.
10. I am responsible for meeting all 2008 A/C Tune-Up Program requirements and complying with my state/county/city governments, property owner and/or homeowners association requirements (if any) in my area regarding local conditions, restrictions, codes, ordinances, rules and regulations concerning this service(s).
11. SCE is not responsible for items lost or destroyed in the mail/transit.
12. You certify that the information you have provided is true and correct, and that the service(s) for which you are requesting a rebate meet(s) the requirements in this application.

This program is funded by California utility ratepayers and administered by SCE under the auspices of the California Public Utilities Commission. Funding for this program is limited and is available on a first-come, first-served basis until allocated funds are exhausted, or July 31, 2008, whichever comes first. This program may be modified or terminated without prior notice.

Appendix B

PG&E AC Quality Care Rebate Application

Together, Building
a Better California

RESIDENTIAL

AC Quality Care Rebate Application

Pacific Gas and Electric Company's (PG&E) AC Quality Care Program offers rebates on a variety of heating, ventilation and air conditioning (HVAC) products and improvements for your home. When you adopt a quality maintenance approach to your HVAC system, you can save energy and money while reducing your impact on the environment.

This application covers products installed on ONE HVAC system at ONE address. If you are applying for rebates for more than one HVAC system or for more than one address, please use separate applications.

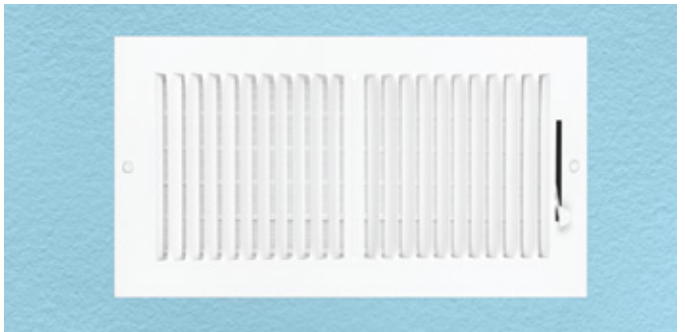
Details about the program

- To be eligible, you must have electricity distributed by PG&E to the installation address.
- Your home must be a single-family residence or duplex of three floors or fewer.
- Participating HVAC contractors will provide, assist in completing and submit the rebate application.
- Your contractor must first perform the Air Conditioning Contractors of America (ACCA) Standard 4 HVAC System Assessment which identifies areas that need maintenance or replacement.
- Your contractor will review assessment results with you and go over the next steps. The contractor will:
  1. Explain the program
  2. Perform the System Assessment to evaluate efficiency, performance and safety
  3. Recommend actions for increased comfort, efficiency and safety
  4. Discuss available PG&E rebates
- Certain rebates apply to specific maintenance measures. Your contractor will provide further information on rebate options, which can include the following: refrigerant system service, replacement of blower motor and one-year quality maintenance service agreement.

How to apply

1. Purchase and install qualifying product(s) or measures during the rebate eligibility term from January 1, 2018 to December 31, 2018.
2. Complete the application with your contractor. You will need to refer to your PG&E bill for your Service Agreement ID Number.
3. Sign the application.
4. Make copies of all documentation for your records.
5. Once work is completed, your contractor will submit the application and any supporting documentation for processing.
6. Rebate checks are generally mailed six to eight weeks after application approval.
7. To ensure the highest quality work, you may be asked to have an inspection performed.

To find a participating AC Quality Care contractor, visit acqualitycarerebate.com or call 1-510-306-ACQC (2272).



What to Expect: PG&E's AC Quality Care Program

Performing the work

Certain steps need to be taken before work begins. For example, your contractor is responsible for obtaining any necessary city and/or county planning or building permits. Most HVAC maintenance measures do not require permits, but they may be required for more extensive renovations. Be sure that your contractor completes all of the work agreed upon in your contract. It's important that the work has been done to your satisfaction.

Obtaining your rebate

Your rebate will be based on the qualified measures you choose. Here's what you can expect after you have completed and signed the Customer Rebate Application:

- Your contractor will submit the application for processing to Build It® Green, a third-party company contracted by PG&E to implement the Program. Unless you have released payment to your contractor, you should expect to receive a rebate check about six to eight weeks after the application has been submitted and approved.
- To ensure energy savings and customer satisfaction, Build It Green and PG&E will review the completed rebate application to confirm that all the necessary information has been provided. On-site inspections (described in the paragraph below) and follow-up corrections by your contractor may also be necessary.

Quality assurance: verifying the work

An inspector from Build It Green and/or PG&E may schedule an in-person visit to ensure that your energy-efficiency measures were installed correctly. This inspection typically lasts about an hour and includes assessing your attic, basement, crawl space or garage to validate that all measures were completed.

PG&E or Build It Green may also contact you to ask about your level of satisfaction with your contractor and request feedback to further improve the Program. These on-site visits and phone calls help PG&E confirm that contractors are providing excellent customer service and making energy improvements that meet the Program's quality standards. Your cooperation is greatly appreciated!

Tips for maximizing your HVAC energy efficiency

Now that you have taken the first steps to ensure that your HVAC system is operating at higher efficiency, here are some easy steps you can take to help keep your HVAC system running smoothly:

Schedule Regular HVAC Checkups: Energy efficiency and air quality are dependent upon maintained systems. HVAC service companies can troubleshoot potential problems during routine maintenance to help keep energy costs down and unexpected repairs to a minimum.

Change Your Air Filter Regularly: One of the most important things you can do to keep your HVAC system working at maximum efficiency is to regularly change your air filter. Ensure that the filter you use is designed to work with your system. If you have questions about how to properly change your system's air filter, your contractor can help answer them.

Use a Programmable Thermostat: PG&E recommends installing a programmable thermostat to maximize energy savings without sacrificing comfort. A programmable thermostat is ideal for people who are away from home during set periods of time throughout the week. Refer to the table below for recommended settings.

Setting	Time	Heating Setpoint	Cooling Setpoint
Wake	6 a.m.	70 °F or lower	70 °F or higher
Day	8 a.m.	62 °F or lower	85 °F or higher
Evening	6 p.m.	70 °F or lower	78 °F or higher
Sleep	10 p.m.	62 °F or lower	82 °F or higher

For more information

It's a win-win-win! You're upgrading your home, helping to reduce California's energy demand and saving money in the process. If you have questions about any of the steps outlined above or would like more information about the program, please call 1-510-306-2272 (ACQC) or send an email to acqualitycare@builditgreen.org.

Visit our website at acqualitycarerebate.com.

Please indicate the measures your contractor has performed and/or installed to Program Requirements

HVAC Quality Maintenance Measure (installed to Program Requirements)	**Rebate**
☐ **Full ACCA Standard 4 HVAC System Assessment with Condenser Coil Cleaning** Must precede any other measures	**$40**
☐ **Refrigerant Charge Adjustment**	**$50**
☐ **Efficient Fan Delay Rebate**	**$70**
☐ **Replacement Blower Motor**	**$220**
☐ **Additional Incentive** Must complete any two of the following: Refrigerant Recharge Adjustment, Efficient Fan Delay, and Blower Motor Replacement	**$100**
TOTAL REBATE PAYMENT	$ 0.00

Customer Signature

I am applying for Rebates based on the information above. I have read and understood the Terms and Conditions (on reverse). I understand my Contractor is responsible for submitting this application to PG&E for processing.

☐ By checking this box, I confirm that I have used a licensed, participating contractor, as appropriate, and followed applicable permitting requirements for the installation of the measures referenced above.

I own the home or received permission from the property owner for the installation of the measures referenced above.

PG&E ACCOUNT HOLDER (print)

EMAIL ADDRESS

SIGN HERE

SIGNATURE

DATE

SERVICE AGREEMENT ID NUMBER
from "Details of Electricity Charges"

PHONE NUMBER

Complete the following section **ONLY** if payment is going to your contractor

Payment Release Authorization (if applicable)

☐ I authorize the payment of my rebate check to the contractor named below, and I understand that I will not be receiving the rebate check from PG&E. I also understand my release of the rebate payment to my contractor does not exempt me from complying with the requirements outlined in this application.

AUTHORIZED BY:

CUSTOMER NAME (printed, as appears on PG&E bill)

CUSTOMER SIGNATURE

DATE

CHECK SHOULD BE MADE PAYABLE TO:

CONTRACTOR NAME

CONTRACTOR LICENSE NUMBER

Terms and Conditions

1. In order to be eligible to receive a Rebate under this Program I understand that I (a) must be a customer of Pacific Gas and Electric Company (PG&E) with an active electric meter serviced by PG&E, (b) must live in a single family residence or duplex of three floors or less with an AC unit installed at the property. I further understand that, in addition to meeting the criteria above, I must also have an active Electric Service Agreement and Account with PG&E at the time the QM Services are rendered and completed. I also understand that if I should enter into a Quality Maintenance (QM) Agreement with my Contractor, that I must have an active Electric Service Agreement and Account with PG&E throughout the duration of the Service Agreement. I understand that if I am having my QM Services performed at more than one residence, I must complete this application and have my Contractor submit a separate application for each individual address and Service Agreement ID #. In this application, the term "perform measures" shall mean the HVAC QM Service was completed per the Program standards.
2. I understand the Program Term is January 1, 2018 through December 31, 2018 (the "Program Term"). Qualifying new measures performed during the Program Term may be eligible for a Rebate. I understand the Program offerings and Rebate amounts may change during the Program Term. Resale products, rebuilt, rented, received from warranty or insurance claims, exchanged, won as a prize, or new parts installed in existing products, do not qualify. The Program may be extended, modified or terminated without prior notice, and the payment of Rebates is subject to the availability of Program funding. To be eligible to receive a Rebate, an application with required documentation must be submitted by my Contractor and received by PG&E no later than 60 calendar days following the installation date of the measures or the expiration of the Program Term.
3. I understand my Contractor is responsible for submitting this application to PG&E. I further understand that it is my responsibility to confirm that my Contractor properly completes the application and submits it to PG&E within the period set forth above in Section 2. Unless an application is selected for verification, a Rebate check is generally mailed 6 to 8 weeks after PG&E receives a completed application from a Contractor. I understand an incomplete application cannot be processed for payment and will be delayed.
4. I will allow, if requested, a representative from PG&E, the California Public Utilities Commission (CPUC), or any authorized third party reasonable access to my property to verify the Contractor's work before a Rebate is paid. I understand that a Rebate will not be paid if I refuse to participate in any required verification. The verification of installation must be scheduled within 30 days of customer contact by PG&E.
5. I understand I cannot receive a Rebate for the same measures from more than one California investor-owned utility or third party energy efficiency program offering rebates, financing or other rebates funded with CPUC Public Goods Charge funds. Products discounted by PG&E at the point of sale are not eligible for additional Rebates under this Program.
6. PG&E MAKES NO REPRESENTATION OR WARRANTY, AND ASSUMES NO LIABILITY WITH RESPECT TO QUALITY, SAFETY, PERFORMANCE, OR OTHER ASPECT OF ANY DESIGN, SYSTEM OR APPLIANCE INSTALLED PURSUANT TO THIS AGREEMENT, AND EXPRESSLY DISCLAIMS ANY SUCH REPRESENTATION, WARRANTY OR LIABILITY. I AGREE TO INDEMNIFY PG&E, ITS AFFILIATES, SUBSIDIARIES, PARENT COMPANY, OFFICERS, DIRECTORS, AGENTS, AND EMPLOYEES AGAINST ALL LOSS, DAMAGE, EXPENSE, FEES, COSTS AND LIABILITY ARISING FROM ANY MEASURES INSTALLED.
7. **NOTE: FOR APPLICANTS THAT ARE TENANTS:** I understand I am solely responsible for obtaining the property owner's written permission in advance of the installation of the product for which I am applying for a Rebate payment. My signature on this application indicates I have obtained this written permission and will submit proof of permission upon PG&E's request.

Appendix C

ACCA Standard 4

AIR CONDITIONING
CONTRACTORS OF AMERICA

2800 Shirlington Road
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Arlington, VA 22206

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www.acca.org

ACCA Standard 4

STANDARD NUMBER: ANSI/ACCA 4 QM – 2013

Maintenance of Residential HVAC Systems

Residential Heating, Ventilating, and Air Conditioning (HVAC) Applications for One- and Two-Family Dwelling of Three Stories or Less

The Air Conditioning Contractors of America Educational Institute (ACCA-EI) Standards Task Team (STT) develops standards as an American National Standards Institute (ANSI) accredited standards developer (ASD). ACCA develops voluntary standards as outlined in the ACCA Essential Requirements and the ANSI Essential Requirements. ACCA standards are developed by diverse groups of industry volunteers in a climate of openness, consensus building, and lack of dominance (e.g., committee/group/team balance). Essential requirements, standard activities and documentation can be found in the standards portion of the ACCA website at www.acca.org. Questions, suggestions, and proposed revisions to this standard can be addressed to the attention of the Standards Task Team, ACCA, 2800 Shirlington Road, Suite 300, Arlington, VA 22206.

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FOREWORD

[This Forward is not part of the standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ACCA or ANSI.]

Heating Ventilating and Air-conditioning (HVAC) Contractors use different approaches for inspecting and maintaining HVAC systems. There are many types and intensity levels of "seasonal tune-ups", "clean and checks", and "maintenance services" performed on HVAC equipment. This standard establishes the minimum level of acceptable compliance for HVAC equipment maintenance inspections for residential applications.

For the public good, it is essential that residential HVAC systems support a comfortable, healthy indoor environment and operate efficiently throughout their lifecycles. This standard provides a nationally-recognized, manufacturer-endorsed set of inspection tasks to meet this need. From this base, consumers can compare the value of the additional recommended corrective actions needed to remedy identified faults. For contractors, it provides a common platform for creating ~~a~~ customized maintenance programs, allowing for bundling different recommended corrective actions at competitive fee structures.

HVAC contractors who perform maintenance on residential HVAC systems should be properly licensed or, where necessary, certified. These contractors should strive to have the highest quality technician perform this standard's tasks for their customers. These technicians should be fully acquainted with the proper operation of the systems they are working on, including the components that comprise the subsystems. Technicians who are certified by an industry-recognized national program have demonstrated that they posses a body of knowledge which supports proper implementation of this standard.

It is recommended that HVAC contractors relate the importance of routine maintenance of the HVAC system to their clients. This will likely take the form of annual/semiannual visits to perform the inspection and applicable remediation actions, though the exact frequency may vary.

The performance objective of the system will be based primarily on the equipment manufacturer's performance data. Acquiring this performance data, however, may be more difficult for older equipment. Original Equipment Manufacturers (OEMs) will generally have performance data for equipment dating back several decades, and the data is usually available at the distributor level.

Some HVAC systems are unable to achieve the manufacturer's performance objectives because the system:

- Was incorrectly designed, selected, or installed, or
- Is beyond the normal service life, or
- Has suffered neglect for long periods of time.

These systems may require levels of remediation beyond the scope of this document or require replacement of the equipment or components. Practitioners are referred to the ACCA 5 QI (Quality Installation Specification) and ACCA 6 QR (Restoring System Cleanliness) Standards. Additionally, other documents listed in Appendix C (Bibliography and Resources) may be helpful to contractors to assess which additional activities may be required.

INTRODUCTION

[This Introduction is not part of the standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ACCA or ANSI.]

Mechanical systems require routine monitoring, adjustments, periodic cleaning, and eventual replacement of components. Regularly scheduled inspections and maintenance are often required to maintain the original equipment manufacturer's (OEM) warranty.

This standard prescribes basic maintenance inspection tasks and offers recommended corrective actions to maintain most residential HVAC systems. It provides checklists for the inspection of typical residential HVAC systems to meet the minimum maintenance requirements. These equipment checklists are divided by equipment type and provide the minimum visual inspections, performance tests, and measurements. The recommended corrective actions provide generic guidance that should return the equipment to good working order.

Conducting regularly scheduled inspections, maintenance, and remediation of HVAC systems prolongs equipment efficiency, promotes healthy clean air, supports lower utility costs, guards against unexpected failures, and prolongs equipment life. Occupants and the environment will both benefit.

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1.0 PURPOSE

The purpose of this standard is to establish minimum inspection requirements in the maintenance of HVAC equipment found in one-family and multi-family dwellings of three stories or less.

2.0 SCOPE

2.1 This standard provides minimum requirements for the inspection, by appropriately licensed HVAC contractors[1], of residential HVAC equipment found in one- or two-family dwellings of three or fewer stories.

2.2 This standard includes checklist tasks for inspecting, testing, and measuring electrical, controls, mechanical, venting, air distribution, and piping systems of residential HVAC systems. The checklists also provides recommended corrective actions which the HVAC contractor shall present to the homeowner to remedy identified faults like cleaning, or adjusting, and/or replacing equipment and components on a periodic basis.

2.3 This standard presumes that the HVAC system was designed, installed, and tested in accordance with original equipment manufacturer's (OEM) instructions, applicable codes, and other industry standards.

2.4 This standard shall not be used to circumvent safety, health, environmental, or the equipment manufacturer's requirements.

3.0 EXECUTION

A maintenance inspection seeks to identify deficiencies that degrade or impair the HVAC system, including its components. The HVAC contractor shall recommend actions to correct these deficiencies. The following are the responsibilities and elements for a maintenance inspection:

3.1 *HVAC contractor's responsibilities*: Appropriately licensed HVAC contractors shall:

- Inspect all HVAC equipment and components to identify faults which contravene the following applicable documents: manufacturer's instructions, manufacturer's warranty requirement, building codes, occupant safety or health standards, environmental regulations, and recognized industry good practices.
- Inform the customer of improper operation finding(s), corrective action(s) taken, corrective action(s) recommended, and the price to complete the recommended action(s).

3.2 *Homeowner's responsibilities*: The homeowner is ultimately responsible for the HVAC equipment's required maintenance. They shall use appropriately licensed and certified HVAC contractor to either perform inspection tasks or implement a maintenance program. The homeowner must understand which corrective actions are included and which corrective actions require their authorization to perform.

3.3 *Maintenance inspection elements*:

3.3.1 *Homeowner(s) interview*:

3.3.1.1 Initial interview: During the first visit to a home, HVAC contractors shall ask questions which help them assess:

3.3.1.1.1 Customers concerns and opinions of their comfort, indoor air quality, utility costs, and equipment performance.

[1] Appropriately licensed HVAC contractors meet the state and local requirements for licensing, insurance, bonding, and proficiency.

3.3.1.1.2 Known home history (when built, renovations, etc.)

3.3.1.2 Subsequent interviews: During following visits, HVAC contractors shall have the discretion to simplify the questions to reveal changes since the last visit.

3.3.2 *Inventory*: Identifying the HVAC system(s) inventory of equipment[2], controls, components, and accessories.

3.3.2.1 Equipment Type (e.g., condenser)

3.3.2.2 Make (e.g., ABC Brand)

3.3.2.3 Model (e.g., AC 1000LMNOP-030)

3.3.2.4 Serial number if applicable (e.g., ABC-123-XYZ)

3.3.2.5 Year of manufacture (e.g., 2007)

3.3.2.6 Start up date (e.g., February 5, 2008) if known

3.3.3 *Equipment maintenance checklists*: From Section 5 (Maintenance Tasks) identify appropriate checklists for each piece of equipment in the inventory,

3.3.4 *Code requirements*: Identify and observe the applicable code references (e.g., International Residential Code, Uniform Mechanical Code, National Fire Protection Association, etc.).

3.3.5 *Performance objectives*: Identify minimum equipment performance criteria based on the manufacturer's performance data and industry standards. The HVAC contractor shall make a reasonable effort to retrieve this performance data from the OEM or a distributor.

3.3.6 *Industry standards*: Follow recognized industry standards (see Appendix C for examples).

3.3.7 *Safety*: If during the maintenance procedures, it is determined that there is a condition that could result in unsafe operation, the contractor shall shut off the equipment and advise the occupant and/or owner, in writing, of the unsafe condition.

3.4 *Regional considerations*: Each region of the country has its own unique set of characteristics (e.g., extreme temperature, humidity, high altitude, fuel sources options, etc.) and special environmental concerns (e.g., sea salt spray). The HVAC contractor shall have the discretion to modify the inspection task list for each piece of equipment to reflect these unique characteristics based on regional guidance from the equipment or accessory manufacturer, municipal ordinances, applicable codes, and other industry standards or good practices.

[2] In the event that the equipment nameplate is missing or illegible, the contractor shall make a reasonable effort to get the information by contacting the OEM or by looking at prior work bills, as available.

4.0 DOCUMENTATION

The HVAC contractor records measurements, observations, and identifies recommended corrective action(s) to maintain the system's ability to efficiently provide clean, conditioned air to the home for its normal expected lifetime. The minimum documentation shall identify:

4.1.1 *Inventory*: The inventory of the equipment for the home's HVAC system(s) per Section 3.3.2.

4.1.2 *Checklists*: Those applicable tasks for the inspected equipment from Section 5.0 Inspection Tasks. Deviations from checklist tasks and requirements shall be detailed.

4.1.3 *Code violations*: Violations of the applicable model codes.

4.1.4 *Performance objectives*: The HVAC system's capability compared to the performance objectives from criteria taken from Section 3.3.5 and OEM performance data.

4.1.5 *External conditions*: Observed circumstances apart from the HVAC system which cause health and safety issues, accelerated wear, poor performance, or increased energy use (e.g., building envelope problems).

4.1.6 *Inaccessible items*: Inform the homeowner of components that are inaccessible or if the limited accessibility of the component impairs the inspection or maintenance task.

4.1.7 *Regional considerations*: The HVAC contractor shall document any modification of a checklist due to a regional consideration, and will provide written justification.

4.1.8 *Corrective actions*: Those tasks, authorized by the home owner or included by the HVAC contractor, undertaken to improve indoor comfort conditions, safety of occupant, system performance, efficiency, or durability.

5.0 MAINTENANCE TASKS

This section identifies inspection tasks and recommended corrective actions for residential HVAC equipment.

5.1 *Inspection tasks*: This portion of the checklist describes the minimum tasks that are required for most major pieces of residential equipment.

5.2 *Recommended corrective actions*: The checklists offer remedies for faults identified during the inspection process. The HVAC contractor shall inform the homeowner of remedies included as part of the inspection and coordinate prior approval for remedies which are not part of the inspection process. All corrective actions shall be performed in accordance with the applicable OEM's instructions. Corrective actions which involve health and safety shall follow the applicable building codes.

5.3 *Component/ equipment listings*: The major pieces of HVAC equipment and accessories have checklists. If the HVAC system in the home is not covered by a checklist, HVAC contractors are to assemble a checklist from similar functions listed on checklists 5.1 – 5.16.

5.4 *Inspection Task scheduling*:

5.4.1 Inspection tasks for cooling and heating shall be performed when the equipment is operating within the temperature parameters established by conditions which meet the manufacturer's operating range.

5.4.2 The HVAC contractor shall have the discretion to increase inspection tasks or frequency of inspection to address deficiencies if unacceptable performance is found during successive inspections.

Component / Equipment	Component / Equipment Description	Checklist Number
Air Distribution System	Plenums, trunk ducts, fittings, branch ducts, boots, grilles, registers and diffusers	5.1
Steam Distribution System	Piping, radiator, controls, steam traps.	5.2
Controls and Safeties	Thermostats, outdoor sensors, humidistats, zone controls	5.3
Furnace	Gas-fired air heating system	5.4
	Oil-fired air heating system	5.5
	Electric air heating system	5.6
Evaporator Coil	The cased or field enclosed evaporator coil, metering device, condensate drain, and associated refrigeration tubing	5.7
Condenser Unit	The outdoor section of a split system: air conditioner or heat pump	5.8
Fan Coil	The filter rack, evaporator coil, metering device, associated refrigeration tubing, blower assembly, condensate drain, and electric auxiliary heat	5.9
Boiler	Gas-fired water heating system	5.10
	Oil-fired water heating system	5.11
	Electric water heating system	5.12
Package Units	Packaged air conditioners or heat pumps	5.13
Geothermal/ Water Source Heat Pumps	Packaged geothermal/water source heat pump units	5.14
Evaporative Coolers	Packaged cooling only equipment using evaporative heat transfer	5.15
Accessories	Heat and energy recovery ventilators, central system humidifiers, central system dehumidifiers, electronic air cleaners, media air cleaners, ultra-violet lights, economizers, and condensate pumps	5.16

Table 1: Component and Equipment Descriptions

Checklist 5.1 Air Distribution System		
#	**Inspection Task**	**Recommended Corrective Actions**
a.	Inspect for particulate accumulation on filters.	Clean or replace filters if accumulation results in PD higher than design or if airflow is outside of established operating limits.
b.	Inspect air filter housing integrity and air seal.	Correct as needed.
c.	Inspect grilles, registers, diffusers, and trunk/branch balancing dampers for dirt accumulation.	Clean as needed.
d.	Inspect all accessible ductwork for areas of moisture accumulation or biological growth.	Install access doors as needed. Clean or replace as needed.
e.	Inspect integrity of all accessible ductwork insulation.	Repair ductwork insulation and associated exterior vapor retarders and repair all accessible rips, voids to insulation adhesives and/or tapes.
f.	Inspect the integrity of all accessible ductwork including: duct strapping, hangers, sections, joints, and seams.	Note improper alterations, straps, air leaks, and failing duct tapes or mastics. Repair, seal, replace as necessary.

Checklist 5.2 Steam Distribution System		
#	**Inspection Task**	**Recommended Corrective Actions**
a.	Inspect safety devices.	Correct or replace as needed per manufacturer's recommendations.
b.	Inspect piping for leaks.	Repair as needed.
c.	Inspect piping anchors/supports for integrity and inspect piping for alignment and expansion fittings for proper operation.	Repair as needed.
d.	Inspect blowdown or drain valve.	Clear all debris to ensure proper operation. Replace as needed.
e.	Inspect system steam traps, pumps, and controls.	Clean or replace as needed to ensure proper operation
f.	Inspect for evidence of buildup or fouling on heat exchange surfaces.	Restore as needed to ensure proper operation.
g.	Inspect for proper fluid flow.	Clean, adjust, and repair as needed to restore proper flow (e.g., drain the boiler annually).
h.	Inspect strainers.	Clean as needed.
i.	Visually inspect external piping insulation and vapor barrier for integrity.	Repair or replace as needed.
j.	Inspect radiator inlet valve and vents.	Open valve and adjust vents as needed.

Checklist 5.3 Controls and Safeties		
#	**Inspection Task**	**Recommended Corrective Actions**
a.	Test modes of operation and control sequences. Test system control devices to ensure they are maintaining their expected range.	Repair or replace controls as needed to ensure proper operation.
b.	Test zoning control's modes of operation, zone control to ensure proper damper/valve operation and test bypass dampers for proper function.	Repair or replace components as needed to ensure proper operation.
c.	Test remote control thermostat in all modes of operation.	Replace battery annually, check for corrosion on the battery contact points.
d.	Initiate a test of the defrost control boards mode of operation, for those with that capability.	Repair, replace or adjust controls as needed.
e.	Test drain pan safety switch(es) for proper operation.	Repair wiring or replace safety switch as needed.
f.	Test unit safety switches[3].	Repair wiring or replace safety switch as needed.
g.	Verify that all selectable pins, jumpers, and/or dip switch positions on control board are correctly positioned for the application.	Use OEM's installation and/or technical publications for guidance on proper settings.

[3] For example, furnace venting pressure switches.

Checklist 5.4 Gas Furnace		
#	**Inspection Task**	**Recommended Corrective Actions**
Cabinet		
a.	Inspect cabinet, cabinet fasteners, and cabinet panels.	Repair or replace insulation to ensure proper operation. Replace lost fasteners as needed to ensure proper integrity and of equipment (as applicable). Seal air leaks.
b.	Inspect the required clearance (e.g., combustion and service) around cabinet.	Record and report instances where the cabinet does not meet requirements.
Electrical		
c.	Inspect electrical disconnect box.	Ensure electrical connections are clean and tight. Ensure fused disconnects use the proper fuse size and are not bypassed. Ensure case is intact and complete. Replace as necessary.
d.	Ensure proper equipment grounding.	Tighten, correct and repair as necessary.
e.	Measure and record line voltage.	Compare to OEM specifications or equipment nameplate data. Notify homeowner and/or utility.
f.	Inspect and test contactors and relays.	Look for pitting or other signs of damage. Replace contactors and relays demonstrating evidence of excessive contact arcing and pitting.
g.	Inspect electrical connections and wire.	Ensure wire size and type match the load conditions. Tighten all loose connections, replace heat discolored connections, and repair or replace any damaged electrical wiring.
h.	Inspect motor capacitors.	Replace those that are bulged, split, incorrectly sized, or do not meet OEM specifications.
i.	Measure and record amperage draw to motor/nameplate data (FLA) as available.	If outside OEM rating or specification, inspect for cause and repair as necessary.
Blower Assembly		
j.	Determine and record airflow across heat exchanger.	Verify all grilles, registers, and balancing dampers are open and free of obstruction and operating properly. Adjust, clean, replace, and repair as necessary to ensure to proper airflow.
k.	Test variable frequency drive (e.g., ECM) for proper operation.	Replace if necessary to ensure proper operation.
l.	Inspect fan belt tension. Inspect belt and pulleys for wear and tear.	Repair or replace as necessary to ensure proper operation (if applicable).
m.	Confirm the fan blade or blower wheel has a tight connection to the blower motor shaft. Inspect fan for free rotation and minimal endplay. Measure and record amp draw.	Lubricate bearings as needed, only if recommended by OEM. If amp draw exceeds OEM specifications then adjust motor speed or otherwise remedy the cause. If due to motor failure recommend replacement of blower motor.
Condensate Removal		
n.	Inspect condensate drain piping (and traps) for proper operation.	Clean, insulate, repair, or replace as necessary.

Gas Combustion		
o.	Inspect burner and flue for signs of water, corrosion, and blockage.	Identify cause and clean, repair, or replace as necessary.
p.	Test inducer fan motor and blower assembly.	Correct as needed.
q.	Inspect heat exchanger for signs of corrosion, fouling, structural problems (e.g., cracks, perforations, and bulges), and erratic flame operation during blower operation.	Identify cause and clean, repair, or replace as necessary.
r.	Visually inspect burners for signs of contamination.	Clean, repair or replace as necessary.
s.	Inspect the burner blower wheel	Clean as needed to ensure proper operation.
t.	Inspect hot surface igniter for cracks (white spots when energized or check cold with ohmmeter and proper supply voltage).	Replace if outside OEM's specifications.
u.	Measure and record inlet gas pressure at inlet pressure tap.	If the inlet gas pressure is insufficient for OEM operation specifications, contact the gas supplier.
v.	Measure, record, and adjust manifold pressure as necessary.	Adjust the gas valve to provide proper manifold pressure.
w.	Inspect ceramic insulator, flame probe, and associated wiring for any cracks or abnormalities.	Clean according to OEM recommended procedures. Replace as needed.
x.	Test main burner ignition sequence and flame safety; verify proper operation.	Record micro-amps for comparison with OEM specifications. If outside of OEM operational range, correct combustion problem or replace components as needed.
y.	Test burners.	Fire unit and adjust air shutters (if used) for OEM specification compliance.
z.	Inspect the spark igniter and associated wiring. Verify that spark gap complies with OEM specifications.	If cracking of ceramic insulator or deterioration of spark electrodes is noted, igniter assembly shall be replaced. If cracking or deterioration of ignition wiring is observed, wiring shall be replaced.
aa.	Test inducer fan motor and blower assembly.	Correct as needed.
bb.	Ensure combustion air volume or provision is correct.	Ensure air volume is correct per OEM instructions and local code[4].
cc.	Perform combustion analysis test. Measure and record test results.	Adjust as needed.
dd.	Measure and record TD across the heat exchanger.	If TD is outside OEM's specifications, identify cause and then clean, repair, or replace as necessary.
Venting		
ee.	Inspect vent exhaust system (e.g., chimney, chimney liner, flue, inlet and exhaust vent) for signs of improper condensation, water corrosion, cracks, fractures, and blockages.	Clean, remove blockages, repair, or replace as necessary.

[4] Direct vent, non-direct vent, and natural draft appliances have differing code requirements for combustion air.

Venting (Continued)		
ff.	Inspect all vent connectors for rust discoloration, or signs of condensate.	Ensure they are securely fastened. Repair or replace as necessary.
gg.	Inspect inlet and exhaust vent pipe for proper support, slope, and termination.	Repair or replace as necessary.
hh.	Inspect for combustible materials placed too close to vent or pipe.	Relocate to safe place or provide approved clearance reduction.

Checklist 5.5 Oil Furnace		
#	**Inspection Task**	**Recommended Corrective Actions**
Cabinet		
a.	Inspect cabinet, cabinet fasteners, and cabinet panels.	Repair or replace insulation to ensure proper operation. Replace lost fasteners as needed to ensure proper integrity and fit/finish of equipment (as applicable). Seal air leaks.
b.	Inspect the required clearance (e.g., combustion and service) around cabinet.	Record and report instances where the cabinet does not meet the requirements.
Electrical		
c.	Inspect electrical disconnect box.	Ensure electrical connections are clean and tight. Ensure fused disconnects use the proper fuse size and are not bypassed. Ensure case is intact and complete. Replace as necessary.
d.	Ensure proper equipment grounding.	Tighten, correct and repair as necessary.
e.	Measure and record line voltage.	Compare to OEM specifications or equipment nameplate data. Notify homeowner and/or utility.
f.	Inspect and test contactors and relays.	Look for pitting or other signs of damage. Replace contactors and relays demonstrating evidence of excessive contact arcing and pitting.
g.	Inspect electrical connections and wire.	Ensure wire size and type match the load conditions. Tighten all loose connections, replace heat discolored connections, and repair or replace any damaged electrical wiring.
h.	Inspect motor capacitors.	Replace those that are bulged, split, incorrectly sized, or do not meet OEM specifications.
i.	Measure and record amperage draw to motor/nameplate data (FLA) as available.	If outside OEM rating or specification, inspect for cause and repair as necessary.
Blower Assembly		
j.	Determine and record airflow across heat exchanger.	Verify all grilles, registers, and balancing dampers are open and free of obstruction and operating properly. Adjust, clean, replace, and repair as necessary to ensure to proper airflow.
k.	Test variable frequency drive (e.g., ECM) for proper operation.	Replace if necessary to ensure proper operation.
l.	Inspect fan belt tension. Inspect belt and pulleys for wear and tear.	Repair or replace as necessary to ensure proper operation (if applicable).
m.	Confirm the fan blade or blower wheel has a tight connection to the blower motor shaft. Inspect fan for free rotation and minimal endplay. Measure and record amp draw.	Lubricate bearings as needed, only if recommended by OEM. If amp draw exceeds OEM specifications then adjust motor speed or otherwise remedy the cause. If due to motor failure recommend replacement of blower motor.
Oil Combustion		
n.	Inspect combustion chamber for structural problems (e.g., cracks, perforations, and deformities).	Identify cause and clean, repair, or replace as necessary.
o.	Inspect heat exchanger and internal flue for signs of corrosion, fouling, and erratic flame operation during blower operation.	Identify cause and clean, repair, or replace as necessary.

Oil Combustion (Continued)		
p.	Inspect all burner gaskets.	Replace any gaskets that are damaged or would fail to seal adequately.
q.	Inspect retention head, electrodes and ceramic insulation.	Clean retention head, electrodes and ceramic insulation of soot and carbon. Change electrodes with ceramic cracks or if tips are rounded.
r.	Inspect electrodes for proper positioning.	Position electrodes as necessary.
s.	Measure and record photo-cell (cad cell) resistance.	Remove photo-cell (cad cell), check resistance, and clean as necessary. Ensure resistance is within OEM specifications.
t.	Verify proper combustion air volume or provisions.	Ensure air volume is correct per OEM instructions and local code. Remove lint or other foreign material around burner combustion air openings that may obstruct airflow.
u.	Verify burner head or nozzle type and location per OEM's specifications.	Adjust as necessary.
v.	Replace oil burner nozzle.	Install new (never attempt cleaning) identical flow rated nozzle (verify gallons per hour, spray angle and pattern).
w.	Replace fuel filter.	Replace filter.
x.	Test burner motor and blower assembly for correct operation.	Correct as needed.
y.	Bleed oil line.	With open fuel supply (cap removed), on a one-pipe system, remove any air from oil line.
z.	Measure and record oil pressure.	Adjust oil pressure as needed, per OEM specification.
aa.	Inspect oil pump and connections for leaks.	Repair leaks as needed.
bb.	On a two line/pipe oil system verify that oil is returning to tank.	Adjust as needed per OEM specifications.
cc.	Measure and record ignition transformer secondary voltage.	Nominal range is 10,000 V ac for iron core transformers. Solid state igniters cannot be tested with an iron core transformer tester.
dd.	Perform combustion analysis test. Measure and record test results.	Adjust as needed.
ee.	Measure and record TD across heat exchanger.	Verify with furnace rating plate, adjust airflow until TD is within OEM's rating.
ff.	Check primary burner control safety timing.	Replace safety control if timing exceeds OEM's specifications.

Venting		
hh.	Inspect vent exhaust system (e.g., chimney, chimney liner, flue, L-vent and exhaust vent) for signs of improper condensation, water, corrosion, cracks, fractures, and blockages.	Clean, remove blockages, repair, or replace as necessary.
ii.	Inspect all vent or chimney connectors for rust discoloration, or signs of condensate.	Repair or replace as necessary.
jj.	Inspect inlet and exhaust vent pipe for proper support, slope, and termination. Ensure they are securely fastened.	Repair or replace as necessary.
kk.	Inspect for combustible materials placed too close to vent or pipe.	Relocate to safe place or provide approved clearance reduction.

Checklist 5.6 Electric Furnace		
#	**Inspection Task**	**Recommended Corrective Actions**
Cabinet		
a.	Inspect cabinet, cabinet fasteners, and cabinet panels.	Repair or replace insulation to ensure proper operation. Replace lost fasteners as needed to ensure proper integrity and fit/finish of equipment (as applicable). Seal air leaks.
b.	Inspect the required clearance (e.g., service) around cabinet.	Record and report instances where the cabinet does not meet the requirements.
Electrical		
c.	Inspect electrical disconnect box.	Ensure electrical connections are clean and tight. Ensure fused disconnects use the proper fuse size and are not bypassed. Ensure case is intact and complete. Replace as necessary.
d.	Ensure proper equipment grounding.	Tighten, correct and repair as necessary.
e.	Measure and record line voltage.	Compare to OEM specifications or equipment nameplate data. Notify homeowner and/or utility.
f.	Inspect and test contactors and relays.	Look for pitting or other signs of damage. Replace contactors and relays demonstrating evidence of excessive contact arcing and pitting.
g.	Inspect electrical connections and wire.	Ensure wire size and type match the load conditions. Tighten all loose connections, replace heat discolored connections, and repair or replace any damaged electrical wiring.
h.	Inspect motor capacitors.	Replace those that are bulged, split, incorrectly sized, or do not meet OEM specifications.
i.	Measure and record amperage draw to motor/nameplate data (FLA) as available.	If outside OEM rating or specification, inspect for cause and repair as necessary.
j.	Test electric heater's capacity and sequence of operation.	If outside OEM rating or sequencer specification, inspect for cause and repair as necessary.
Blower Assembly		
k.	Determine and record airflow across heating elements.	Verify all grilles, registers, and balancing dampers are open and free of obstruction. Adjust, clean, replace, and repair as necessary to ensure to proper airflow.
l.	Test variable frequency drive (e.g., ECM) for proper operation.	Replace if necessary to ensure proper operation.
m.	Inspect fan belt tension. Inspect belt and pulleys for wear and tear.	Repair or replace as necessary to ensure proper operation (if applicable).
n.	Confirm the fan blade or blower wheel has a tight connection to the blower motor shaft. Inspect fan for free rotation and minimal endplay. Measure and record amp draw.	Lubricate bearings as needed, only if recommended by OEM. If amp draw exceeds OEM specifications then adjust motor speed or otherwise remedy the cause. If due to motor failure recommend replacement of blower motor.

Checklist 5.7 Evaporator Coil		
#	**Inspection Task**	**Recommended Corrective Actions**
Cabinet		
a.	Inspect cabinet, cabinet fasteners, and cabinet panels.	Repair or replace insulation to ensure proper operation. Replace lost fasteners as needed to ensure proper integrity and fit/finish of equipment (as applicable). Seal air leaks.*
b.	Inspect the required clearance (e.g., service) around cabinet. Ensure no obstacles to airflow have been installed that would impede airflow.	Record and report instances where the cabinet does not meet the requirements.
Condensate Removal		
c.	Inspect condensate drain piping (and traps) for proper operation.	Clean, insulate, repair, or replace as necessary.
d.	Inspect for condensate blowing from coil into cabinet or air distribution system.*	Adjust fan speed, clean coil fins, ensure OEM supplied deflectors are in place, or replace coil as necessary to eliminate water carry over.
e.	Inspect drain pan and accessible drain line for biological growth.	Clean as needed to remove bio growth and ensure proper operation, add algae tablets or strips as necessary. Ensure algae tablets and cleaning agent are compatible with the fin and tube material.
f.	Inspect secondary drain lines, drain pans, and overflow protection devices, as applicable, for proper drain flow and evidence of water in secondary drain pan.*	Remove any blockages and investigate cause of recent water in drain pan.
Refrigeration		
g.	Confirm correct airflow using delta-T and/or static pressure, and compare to OEM target.	Adjust the system for proper airflow.
h.	Measure and record dry bulb and wet bulb TD across evaporator coil.[5]*	If DB and/or WB values are outside of appropriate OEM ranges, check for correct airflow, refrigerant charge, and operating conditions.
i.	Inspect coil fins.	Ensure fins are visibly clean, straight, and open. Clean and straighten as required.
j.	Inspect accessible refrigerant lines, joints, components, and coils for oil leaks.	Test all oil stained joints for leaks, clean or repair as necessary.
k.	Inspect refrigerant line insulation.	Repair or replace refrigerant line insulation.
l.	Measure pressure drop across the coil.*	Adjust, clean, replace, and repair as necessary to ensure to proper airflow.
* Does not apply to wall- or ceiling mounted evaporator units matched with a ductless mini split.		

[5] This is a minimum standard procedure, and a good diagnostic field practice is to measure superheat or subcooling to ensure proper refrigerant charge. See OEM instructions for inverter-driven equipment.

Checklist 5.8 Condensing Unit		
#	**Inspection Task**	**Recommended Corrective Actions**
Cabinet		
a.	Inspect cabinet, cabinet fasteners, and cabinet panels.	Repair or replace insulation to ensure proper operation. Replace lost fasteners as needed to ensure proper integrity and fit/finish of equipment (as applicable). Seal air leaks.*
b.	Inspect the required clearance (e.g., service) around cabinet.	Record and report instances where the cabinet does not meet the requirements.
Electrical		
c.	Inspect electrical disconnect box.	Ensure electrical connections are clean and tight. Ensure fused disconnects use the proper fuse size and are not bypassed. Ensure the case is intact and complete. Replace as necessary.
d.	Ensure proper equipment grounding.	Tighten, correct and repair as necessary.
e.	Measure and record line voltage.	Compare to OEM specifications or equipment nameplate data. Notify homeowner and/or utility.
f.	Inspect and test contactors and relays.	Look for pitting or other signs of damage. Replace contactors and relays demonstrating evidence of excessive contact arcing and pitting.
g.	If accessible, check printed circuit for hot spots and other damage.	Replace as necessary.
h.	Inspect electrical connections and wire.	Ensure wire size and type match the load conditions. Tighten all loose connections, replace heat discolored connections, and repair or replace any damaged electrical wiring.
i.	Inspect motor capacitors.	Replace those that are bulged, split, incorrectly sized, or do not meet OEM specifications.
j.	Measure and record amperage draw to motor/nameplate data (FLA) as available.	If outside OEM rating or specification, inspect for cause and repair as necessary.
Refrigeration		
k.	Inspect accessible refrigerant lines, joints, components, and coils for oil leaks.	Test all oil stained joints for leaks, clean or repair as necessary.
l.	If indoor airflow is within OEM specifications but TD is not (see Checklist 5.7 #h), check refrigerant charge using manufacturer recommended procedure.[6]	Adjust charge as necessary[7].
m.	Inspect refrigerant line insulation.	Repair or replace refrigerant line insulation.
Condenser Fan Motor		
n.	Confirm the fan blade or blower wheel has a tight connection to the blower motor shaft. Inspect fan for free rotation and minimal endplay. Measure and record amp draw.	Lubricate bearings as needed, only if recommended by OEM. If amp draw exceeds OEM specifications then adjust motor speed or otherwise remedy the cause. If due to motor failure recommend replacement of blower motor.
Condenser Coil		
o.	Inspect coil fins.	Clean, straighten, and repair as required.

[6] A good diagnostic field practice is to measure superheat or subcooling to ensure proper refrigerant charge.
[7] Ensure that the metering device (and sensing bulb) is properly installed.

Checklist 5.8 - HP Additional Tasks for Air-to-Air Heat Pump Condensers		
#	**Inspection Task**	**Recommended Corrective Actions**
a.	Test reversing valve operation.	Record findings, repair replace as necessary.
b.	If indoor airflow is within OEM specifications but TD is not, check refrigerant charge using manufacturer recommended procedure.[8]	Adjust charge as necessary[9].
c.	Test defrost cycle controls.	Repair, replace or adjust controls as needed.
d.	Inspect outdoor unit condensate drain ports.	Ensure condensate drain ports are open and the unit is elevated above obstructions to allow free flow of condensate or per local code for seasonal obstructions like snow.

[8] A good diagnostic field practice is to measure superheat or subcooling to ensure proper refrigerant charge.
[9] Ensure that the metering device (and sensing bulb) is properly installed.

Checklist 5.9 Fan Coil		
#	**Inspection Task**	**Recommended Corrective Actions**
Cabinet		
a.	Inspect cabinet, cabinet fasteners, and cabinet panels.	Repair or replace insulation to ensure proper operation. Replace lost fasteners as needed to ensure proper integrity and fit/finish of equipment (as applicable). Seal air leaks.
b.	Inspect the required clearance (e.g., service) around cabinet.	Record and report instances where the cabinet does not meet the requirements.
Electrical		
c.	Inspect electrical disconnect box.	Ensure electrical connections are clean and tight. Ensure fused disconnects use the proper fuse size and are not bypassed. Ensure case is intact and complete. Replace as necessary.
d.	Ensure proper equipment grounding.	Tighten, correct and repair as necessary.
e.	Measure and record line voltage.	Compare to OEM specifications or equipment nameplate data. Notify homeowner and/or utility.
f.	Inspect and test contactors and relays.	Look for pitting or other signs of damage. Replace contactors and relays demonstrating evidence of excessive contact arcing and pitting.
g.	Inspect electrical connections and wire.	Ensure wire size and type match the load conditions. Tighten all loose connections, replace heat discolored connections, and repair or replace any damaged electrical wiring.
h.	Inspect motor capacitors.	Replace those that are bulged, split, incorrectly sized, or do not meet OEM specifications.
i.	Measure and record amperage draw to motor/nameplate data (FLA) as available.	If outside OEM rating or specification, inspect for cause and repair as necessary.
Blower Assembly		
j.	Determine and record airflow across heat exchanger/coil.	Verify all grilles, registers, and balancing dampers are open and free of obstruction and operating properly. Adjust, clean, replace, and repair as necessary to ensure to proper airflow.
k.	Test variable frequency drive (e.g., ECM) for proper operation.	Replace if necessary to ensure proper operation.
l.	Inspect fan belt tension. Inspect belt and pulleys for wear and tear.	Repair or replace as necessary to ensure proper operation (if applicable).
m.	Confirm the fan blade or blower wheel has a tight connection to the blower motor shaft. Inspect fan for free rotation and minimal endplay. Measure and record amp draw.	Lubricate bearings as needed, only if recommended by OEM. If amp draw exceeds OEM specifications then adjust motor speed or otherwise remedy the cause. If due to motor failure recommend replacement of blower motor.
Evaporator Coil		
n.	Inspect coil, refrigeration components, fittings and fins.	Check for signs of refrigerant leaks. Ensure fins are clean, straight, and open. Clean and straighten as required.
o.	Confirm correct airflow using delta-T and/or static pressure, and compare to OEM target.	Adjust the system for proper airflow.
p.	Measure and record dry bulb and wet bulb TD across evaporator coil.	If DB and/or WB values are outside of appropriate OEM ranges, check for correct airflow, refrigerant charge, and operating conditions.
q.	Inspect refrigerant line insulation.	Repair or replace refrigerant line insulation.

Condensate Removal		
r.	Inspect for condensate blowing from coil into cabinet or air distribution system.	Adjust fan speed, clean coil fins, ensure OEM supplied deflectors are in place, or replace coil as necessary to eliminate water carry over.
s.	Inspect condensate drain piping (and traps) for proper operation.	Clean, insulate, repair, or replace as necessary.
t.	Inspect drain pan and accessible drain line for biological growth.	Clean as needed to remove bio growth and ensure proper operation, add algae tablets or strips as necessary. Ensure algae tablets and cleaning agent are compatible with the fin and tube material.
Auxiliary or Supplemental Electric Heaters		
u.	Test electric heater's capacity and sequence of operation.	If outside OEM rating or sequencer specification, inspect for cause and repair as necessary.

Checklist 5.10 Gas Boiler		
#	**Inspection Task**	**Recommended Corrective Actions**
Cabinet		
a.	Inspect cabinet, cabinet fasteners, and cabinet panels.	Repair or replace insulation to ensure proper operation. Replace lost fasteners as needed to ensure proper integrity and fit/finish of equipment (as applicable).
b.	Inspect the required clearance (e.g., combustion and service) around cabinet.	Record and report instances where the cabinet does not meet the requirements.
Electrical		
c.	Inspect electrical disconnect box.	Ensure electrical connections are clean and tight. Ensure fused disconnects use the proper fuse size and are not bypassed. Ensure case is intact and complete. Replace as necessary.
d.	Ensure proper equipment grounding.	Tighten, correct and repair as necessary.
e.	Measure and record line voltage.	Compare to OEM specifications or equipment nameplate data. Notify homeowner and/or utility.
f.	Inspect and test contactors and relays.	Look for pitting or other signs of damage. Replace contactors and relays demonstrating evidence of excessive contact arcing and pitting.
g.	Inspect electrical connections and wire.	Ensure wire size and type match the load conditions. Tighten all loose connections, replace heat discolored connections, and repair or replace any damaged electrical wiring.
h.	Inspect motor capacitors.	Replace those that are bulged, split, incorrectly sized, or do not meet OEM specifications.
i.	Measure and record amperage draw to motor/nameplate data (FLA) as available.	If outside OEM rating or specification, inspect for cause and repair as necessary.
Gas Combustion		
j.	Inspect combustion chamber, burner and flue.	Look for signs of water, corrosion, and blockage.
k.	Inspect heat exchanger for signs of corrosion, fouling, structural problems (e.g., cracks, perforations, and bulges), and erratic flame operation during blower operation.	Clean or replace as needed.
l.	Visually inspect burners for signs of contamination.	Clean, repair or replace as necessary.
m.	Inspect the burner blower wheel	Clean as needed to ensure proper operation.
n.	Inspect hot surface igniter for cracks (white spots when energized or check cold with ohmmeter and proper supply voltage).	Replace if outside OEM's specifications.
o.	Measure and record inlet gas pressure at inlet pressure tap.	If the inlet gas pressure is insufficient for OEM operation specifications, contact the gas supplier.
p.	Measure, record, and adjust manifold pressure as necessary.	Adjust the gas valve to provide proper manifold pressure.
q.	Test main burner ignition.	Replace thermocouple or flame sensor/pilot assembly if outside of OEM recommended operational range under load.

Gas Combustion (Continued)		
r.	Test burners.	Fire unit and adjust air shutters (if used) for OEM specification compliance.
s.	Test inducer fan motor and blower assembly.	Correct as needed.
t.	Ensure combustion air volume is correct.	Ensure air volume is correct per local code.
u.	Perform combustion analysis test. Measure and record test results.	Adjust as needed.
v.	Measure and record TD across the heat exchanger.	Clean components or adjust waterflow as necessary to meet necessary operating conditions and design parameters.
Hydronic Loop		
w.	Inspect screen on reducing valve, pressure reducing valve, and "Y" strainer if available.	Clean or replace as necessary.
x.	Test bladder expansion tank for proper air cushion or proper air cushion on expansion tank.	Adjust to provide proper air cushion on expansion tank as per manufactures specifications.
y.	Inspect water pump.	Clean or clear as needed to reduce cavitation and ensure proper operation.
z.	Measure and record TD of water entering to water leaving coil/ heat exchanger.	Adjust flow rate as necessary.
aa.	Measure and record PD of the water loop across the water heat exchanger.	Adjust water pump or control valve as necessary.
Venting		
bb.	Inspect inside of chimney/ flue/ inlet and exhaust vent for water, signs of condensation, corrosion, cracks, fractures, and blockages.	Clean, remove blockages, repair, or replace as necessary.
cc.	Inspect all vent connectors for rust discoloration, or signs of condensate.	Ensure they are securely fastened. Repair or replace as necessary.
dd.	Inspect inlet and exhaust vent pipe for proper support, slope, and termination.	Repair or replace as necessary.
ee.	Inspect for combustible materials placed too close to vent or pipe.	Relocate to safe place or provide approved clearance reduction.

Checklist 5.11 Oil Boiler		
#	**Inspection Task**	**Recommended Corrective Actions**
Cabinet		
a.	Inspect cabinet, cabinet fasteners, and cabinet panels.	Repair or replace insulation to ensure proper operation. Replace lost fasteners as needed to ensure proper integrity and fit/finish of equipment (as applicable).
b.	Inspect the required clearance (e.g., combustion and service) around cabinet.	Record and report instances where the cabinet does not meet the requirements.
Electrical		
c.	Inspect electrical disconnect box.	Ensure electrical connections are clean and tight. Ensure fused disconnects use the proper fuse size and are not bypassed. Ensure case is intact and complete. Replace as necessary.
d.	Ensure proper equipment grounding.	Tighten, correct and repair as necessary.
e.	Measure and record line voltage.	Compare to OEM specifications or equipment nameplate data. Notify homeowner and/or utility.
f.	Inspect and test contactors and relays.	Look for pitting or other signs of damage. Replace contactors and relays demonstrating evidence of excessive contact arcing and pitting.
g.	Inspect electrical connections and wire.	Ensure wire size and type match the load conditions. Tighten all loose connections, replace heat discolored connections, and repair or replace any damaged electrical wiring.
h.	Inspect motor capacitors.	Replace those that are bulged, split, incorrectly sized, or do not meet OEM specifications.
i.	Measure and record amperage draw to motor/nameplate data (FLA) as available.	If outside OEM rating or specification, inspect for cause and repair as necessary.
Oil Combustion		
j.	Inspect combustion chamber for structural problems (e.g., cracks, perforations, and bulges).	Identify cause and clean, repair, or replace as necessary.
k.	Inspect heat exchanger and internal flue for signs of corrosion, fouling, structural problems (e.g., cracks, perforations, and bulges), and erratic flame operation during blower operation.	Identify cause and clean, repair, or replace as necessary.
l.	Inspect all burner gaskets.	Replace any gaskets that are damaged or would fail to seal adequately.
m.	Inspect retention head, electrodes and ceramic insulation.	Clean retention head, electrodes and ceramic insulation of soot and carbon. Change electrodes with ceramic cracks or if tips are rounded.
n.	Inspect electrodes for proper positioning.	Position electrodes as necessary.
o.	Measure and record photo-cell (cad cell) resistance.	Remove photo-cell (cad cell), check resistance, and clean as necessary. Ensure resistance is within OEM specifications.
p.	Clean combustion air inlet.	Remove lint or other foreign material around burner combustion air openings that may obstruct airflow.

Oil Combustion (Continued)		
q.	Verify burner head or nozzle type and location per OEM's specifications.	Make all adjustments as necessary.
r.	Replace oil burner nozzle.	Install new (never attempt cleaning) identical flow rated nozzle (verify gallons per hour, spray angle and pattern).
s.	Replace fuel filter.	Replace filter.
t.	Test inducer fan motor and blower assembly.	Correct as needed.
u.	Bleed oil line.	With open fuel supply (cap removed), on a one-pipe system, remove any air from oil line.
v.	Measure, adjust, and record oil pressure.	Measure and adjust oil pressure.
w.	Inspect oil pump for proper pressure and leaks.	If pump pressure is below OEM specifications or there are signs of leaks, remove oil pump cover and gasket. Discard gasket. With fine-bristle brush and solvent, then clean strainer or replace. Reassemble with new gasket. Retest pump.
x.	Test fuel pump for proper operation, pressure, and cut-off. Measure and record line vacuum.	Install a pressure gauge in the nozzle port and run the burner to observe operating pressure and record. Shut the burner off and record cut-off pressure. If the cut-off pressure drops below OEM specifications replace pump or add check valve.
y.	Measure and record ignition transformer secondary voltage.	Nominal range is 10,000 V ac for iron core transformers. Solid state igniters cannot be tested with an iron core transformer tester.
z.	Ensure combustion air volume is correct.	Ensure air volume is correct per local code.
aa.	Perform combustion analysis test. Measure and record test results.	Adjust as needed.
bb.	Measure and record TD across heat exchanger.	Verify with furnace rating plate. If TD is outside OEM's rating, identify cause and then clean, repair, or replace as necessary.
cc.	Check primary control safety timing.	Disconnect the cad cell and run the burner and time the lockout. Replace safety control if timing exceeds OEM's specifications.
Hydronic Loop		
dd.	Inspect screen on reducing valve, pressure reducing valve, and "Y" strainer if available.	Clean or replace as necessary.
ee.	Test bladder/expansion tank for proper air cushion or proper air cushion on expansion tank.	Adjust to provide proper air cushion on expansion tank as per manufactures specifications.
ff.	Inspect water pump.	Clean or clear as needed to reduce cavitation and ensure proper operation.
gg.	Measure and record PD of the water loop across the refrigerant water heat exchanger.	Adjust water pump or control valve as necessary.
Hydronic Loop (Continued)		
hh.	Measure and record TD of water entering to water leaving coil/ heat exchanger.	If TD is outside OEM's specifications, identify cause and then clean, repair, or replace as necessary.
ii.	Inspect auto air vent and check for air in system.	Clean or replace air vents as necessary.

Venting		
jj.	Inspect inside of chimney/ flue/ inlet and exhaust vent for water, signs of condensation, corrosion, cracks, fractures, and blockages.	Clean, remove blockages, repair, or replace as necessary.
kk.	Inspect all vent connectors for rust discoloration, or signs of condensate.	Ensure they are securely fastened. Repair or replace as necessary.
ll.	Inspect inlet and exhaust vent pipe for proper support, slope, and termination.	Repair or replace as necessary.
mm.	Inspect for combustible materials placed too close to vent or pipe.	Relocate to safe place or provide approved clearance reduction.

Checklist 5.12 Electric Boiler		
#	**Inspection Task**	**Recommended Corrective Actions**
Cabinet		
a.	Inspect cabinet, cabinet fasteners, and cabinet panels.	Repair or replace insulation to ensure proper operation. Replace lost fasteners as needed to ensure proper integrity and fit/finish of equipment (as applicable). Seal air leaks.
b.	Inspect the required clearance (e.g., service) around cabinet.	Record and report instances where the cabinet does not meet the requirements.
Electrical		
c.	Inspect electrical disconnect box.	Ensure electrical connections are clean and tight. Ensure fused disconnects use the proper fuse size and are not bypassed. Ensure case is intact and complete. Replace as necessary.
d.	Ensure proper equipment grounding.	Tighten, correct and repair as necessary.
e.	Measure and record line voltage.	Compare to OEM specifications or equipment nameplate data. Notify homeowner and/or utility.
f.	Inspect and test contactors and relays.	Look for pitting or other signs of damage. Replace contactors and relays demonstrating evidence of excessive contact arcing and pitting.
g.	Inspect electrical connections and wire.	Ensure wire size and type match the load conditions. Tighten all loose connections, replace heat discolored connections, and repair or replace any damaged electrical wiring.
h.	Inspect motor capacitors.	Replace those that are bulged, split, incorrectly sized, or do not meet OEM specifications.
i.	Measure and record amperage draw to motor/nameplate data (FLA) as available.	If outside OEM rating or specification, inspect for cause and repair as necessary.
Electric Water Heating		
j.	Measure and record TD of water entering to water leaving heat exchanger.	If outside OEM rating or specification, inspect for cause and repair as necessary.
k.	Test electric heater's capacity and sequence of operation.	If outside OEM rating or sequencer specification, inspect for cause and repair as necessary.
Hydronic Loop		
l.	Inspect screen on reducing valve, pressure reducing valve, and "Y" strainer if available.	Clean or replace as necessary.
m.	Test bladder expansion tank for proper air cushion or proper air cushion on expansion tank.	Adjust to provide proper air cushion on expansion tank as per manufactures specifications.
n.	Inspect water pump.	Clean or clear as needed to reduce cavitation and ensure proper operation.
o.	Measure and record TD of water entering to water leaving coil/ heat exchanger.	Add or remove refrigerant or adjust firing rate as necessary.
p.	Measure and record PD of the water loop across the refrigerant water heat exchanger.	Adjust water pump or control valve as necessary.

Checklist 5.13 Package Units		
#	**Inspection Task**	**Recommended Corrective Actions**
Cabinet		
a.	Inspect cabinet, cabinet fasteners, and cabinet panels.	Repair or replace insulation to ensure proper operation. Replace lost fasteners as needed to ensure proper integrity and fit/finish of equipment (as applicable). Seal air leaks on indoor air processing sections.
b.	Inspect the required clearance (e.g., combustion and service) around cabinet.	Record and report instances where the cabinet does not meet the requirements.
Electrical		
c.	Inspect electrical disconnect box.	Ensure electrical connections are clean and tight. Ensure fused disconnects use the proper fuse size and are not bypassed. Ensure case is intact and complete. Replace as necessary.
d.	Ensure proper equipment grounding.	Tighten, correct and repair as necessary.
e.	Measure and record line voltage.	Compare to OEM specifications or equipment nameplate data. Notify homeowner and/or utility.
f.	Inspect and test contactors and relays.	Look for pitting or other signs of damage. Replace contactors and relays demonstrating evidence of excessive contact arcing and pitting.
g.	Inspect electrical connections and wire.	Ensure wire size and type match the load conditions. Tighten all loose connections, replace heat discolored connections, and repair or replace any damaged electrical wiring.
h.	Inspect motor capacitors.	Replace those that are bulged, split, incorrectly sized, or do not meet OEM specifications.
i.	Measure and record amperage draw to motor/nameplate data (FLA) as available.	If outside OEM rating or specification, inspect for cause and repair as necessary.
Indoor Blower Motor		
j.	Determine and record airflow across heat exchanger/coil.	Verify all grilles, registers, and balancing dampers are open and free of obstruction and operating properly. Adjust, clean, replace, and repair as necessary to ensure to proper airflow.
k.	Test variable frequency drive (e.g., ECM) for proper operation.	Replace if necessary to ensure proper operation.
l.	Inspect fan belt tension. Inspect belt and pulleys for wear and tear.	Repair or replace as necessary to ensure proper operation (if applicable).
m.	Confirm the fan blade or blower wheel has a tight connection to the blower motor shaft. Inspect fan for free rotation and minimal endplay. Measure and record amp draw.	Lubricate bearings as needed, only if recommended by OEM. If amp draw exceeds OEM specifications then adjust motor speed or otherwise remedy the cause. If due to motor failure recommend replacement of blower motor.
Evaporator Coil Section		
n.	Inspect coil fins.	Ensure fins are clean, straight, and open. Clean and straighten as required.
o.	Inspect for condensate blowing from coil into cabinet or air distribution system.	Adjust fan speed, clean coil fins, or replace coil as necessary to eliminate water carry over.
p.	Inspect accessible refrigerant connecting lines, joints, and coils for oil leaks.	Test all oil stained joints for leaks, clean or repair as necessary.

Evaporator Coil Section (Continued)		
q.	Confirm correct airflow using delta-T and/or static pressure, and compare to OEM target.	Adjust the system for proper airflow.
r.	Measure and record dry bulb and wet bulb TD across evaporator coil[10].	If DB and/or WB values are outside of appropriate OEM ranges, check for correct airflow, refrigerant charge, and operating conditions.
Condensate Removal		
s.	Inspect for condensate blowing from coil into cabinet or air distribution system.	Adjust fan speed, clean coil fins, ensure OEM supplied deflectors are in place, or replace coil as necessary to eliminate water carry over.
t.	Inspect condensate drains (and traps) for proper operation.	Clean, insulate, repair, or replace as necessary.
u.	Inspect drain pan and accessible drain line for biological growth.	Clean as needed to remove bio growth and ensure proper operation, add algae tablets or strips as necessary. Ensure algae tablets and cleaning agent are compatible with the fin and tube material.
Condenser Blower Motor		
v.	Confirm the fan blade or blower wheel has a tight connection to the blower motor shaft. Inspect fan for free rotation and minimal endplay. Measure and record amp draw.	Lubricate bearings as needed, only if recommended by OEM. If amp draw exceeds OEM specifications then adjust motor speed or otherwise remedy the cause. If due to motor failure recommend replacement of blower motor.
Condenser Coil Section		
w.	Inspect coil fins.	Ensure fins are clean, straight, and open. Clean and straighten as required.
x.	Inspect accessible refrigerant connecting lines, joints, and coils for oil leaks.	Test all oil stained joints for leaks, clean or repair as necessary.
Refrigeration		
y.	Inspect accessible refrigerant connecting lines, joints, and coils for oil leaks.	Test all oil stains for leaks, clean or repair as necessary.
z.	If indoor airflow is within OEM specifications but TD is not, check refrigerant charge using manufacturer recommended procedure[11].	Adjust charge as necessary[12].
Auxiliary or Supplemental Electric Heaters		
aa.	Test electric heater's capacity and sequence of operation.	If outside OEM rating or sequencer specification, inspect for cause and repair as necessary.

[10] This is a minimum standard procedure, and a good diagnostic field practice is to measure superheat or subcooling to ensure proper refrigerant charge.
[11] A good diagnostic field practice is to measure superheat or subcooling to ensure proper refrigerant charge.
[12] Ensure that the metering device (and sensing bulb) is properly installed.

Checklist 5.13-HP Additional Tasks for Package Heat Pumps		
#	**Inspection Task**	**Recommended Corrective Actions**
a.	Test reversing valve operation.	Record findings, repair replace as necessary.
b.	If indoor airflow is within OEM specifications but TD is not, check refrigerant charge using manufacturer recommended procedure.[13]	Adjust charge as necessary[14].
c.	Test defrost cycle controls.	Repair, replace or adjust controls as needed.
d.	Inspect condenser section condensate drain ports.	Ensure condensate drain ports are open and elevated above obstructions to allow free flow of condensate or per local code for seasonal obstructions like snow.

[13] A good diagnostic field practice is to measure superheat or subcooling to ensure proper refrigerant charge.
[14] Ensure that the metering device (and sensing bulb) is properly installed.

Checklist 5.13-GP Additional Tasks for Gas Package Units		
#	**Inspection Task**	**Recommended Corrective Actions**
Gas Combustion		
a.	Inspect combustion chamber, burner and flue.	Look for signs of water, corrosion, and blockage.
b.	Inspect heat exchanger for signs of corrosion, fouling, structural problems (e.g., cracks, perforations, and bulges), and erratic flame operation during blower operation.	Clean or replace as needed.
c.	Visually inspect burners for signs of contamination.	Clean, repair or replace as necessary.
d.	Inspect the burner blower wheel	Clean as needed to ensure proper operation.
e.	Inspect hot surface igniter for cracks (white spots when energized or check cold with ohmmeter and proper supply voltage).	Replace if outside OEM's specifications.
f.	Measure and record inlet gas pressure at inlet pressure tap.	If the inlet gas pressure is insufficient for OEM operation specifications, contact the gas supplier.
g.	Measure, record, and adjust manifold pressure as necessary.	Adjust the gas valve to provide proper manifold pressure.
h.	Test main burner ignition.	Clean thermocouple or flame sensor/pilot assembly.
i.	Test burners.	Fire unit and adjust air shutters (if used) for OEM specification compliance.
j.	Test inducer fan motor and blower assembly.	Correct as needed.
k.	Ensure combustion air volume is correct.	Ensure air volume is correct per local code.
l.	Perform combustion analysis test. Measure and record test results.	Adjust as needed.
m.	Measure and record TD across the heat exchanger.	Clean components or adjust airflow as necessary to meet necessary operating conditions and design parameters.
Venting		
n.	Inspect vent termination for water, signs of condensation, corrosion, cracks, fractures, and blockages.	Clean, remove blockages, repair, or replace as necessary.
o.	Inspect all vent connectors for rust discoloration, or signs of condensate.	Ensure they are securely fastened. Repair or replace as necessary.
p.	Inspect inlet and exhaust vent pipe for proper support, slope, and termination.	Repair or replace as necessary.
q.	Inspect for combustible materials placed too close to vent or pipe.	Relocate to safe place.

Checklist 5.14 Geothermal		
#	**Inspection Task**	**Recommended Corrective Actions**
Cabinet		
a.	Inspect cabinet, cabinet fasteners, and cabinet panels.	Repair or replace insulation to ensure proper operation. Replace lost fasteners as needed to ensure proper integrity and fit/finish of equipment (as applicable). Seal air leaks.
b.	Inspect the required clearance (e.g., service) around cabinet.	Record and report instances where the cabinet does not meet the requirements.
Electrical		
c.	Inspect electrical disconnect box.	Ensure electrical connections are clean and tight. Ensure fused disconnects use the proper fuse size and are not bypassed. Ensure case is intact and complete. Replace as necessary.
d.	Ensure proper equipment grounding.	Tighten, correct and repair as necessary.
e.	Measure and record line voltage.	Compare to OEM specifications or equipment nameplate data. Notify homeowner and/or utility.
f.	Inspect and test contactors and relays.	Look for pitting or other signs of damage. Replace contactors and relays demonstrating evidence of excessive contact arcing and pitting.
g.	Inspect electrical connections and wire.	Ensure wire size and type match the load conditions. Tighten all loose connections, replace heat discolored connections, and repair or replace any damaged electrical wiring.
h.	Inspect motor capacitors.	Replace those that are bulged, split, incorrectly sized, or do not meet OEM specifications.
i.	Measure and record amperage draw to motor/nameplate data (FLA) as available.	If outside OEM rating or specification, inspect for cause and repair as necessary.
Indoor Blower Motor		
j.	Determine and record airflow across heat exchanger/coil.	Verify all grilles, registers, and balancing dampers are open and free of obstruction and operating properly. Adjust, clean, replace, and repair as necessary to ensure to proper airflow.
k.	Test variable frequency drive (e.g., ECM) for proper operation.	Replace if necessary to ensure proper operation.
l.	Inspect fan belt tension. Inspect belt and pulleys for wear and tear.	Repair or replace as necessary to ensure proper operation (if applicable).
m.	Confirm the fan blade or blower wheel has a tight connection to the blower motor shaft. Inspect fan for free rotation and minimal endplay. Measure and record amp draw.	Lubricate bearings as needed, only if recommended by OEM. If amp draw exceeds OEM specifications then adjust motor speed or otherwise remedy the cause. If due to motor failure recommend replacement of blower motor.
Condensate Removal		
n.	Inspect for condensate blowing from coil into cabinet or air distribution system.	Adjust fan speed, clean coil fins, ensure OEM supplied deflectors are in place, or replace coil as necessary to eliminate water carry over.
o.	Inspect condensate drain piping (and traps) for proper operation.	Clean, insulate, repair, or replace as necessary.
p.	Inspect drain pan and accessible drain line for biological growth.	Clean as needed to remove bio growth and ensure proper operation, add algae tablets or strips as necessary. Ensure algae tablets and cleaning agent are compatible with the fin and tube material.

Air Side Coil		
q.	Inspect coil fins.	Ensure fins are straight and open. Clean and straighten as required.
r.	Inspect for condensate blowing from coil into cabinet or air distribution system.	Adjust fan speed, clean coil fins, or replace coil as necessary to eliminate water carry over.
s.	Confirm correct airflow using delta-T and/or static pressure, and compare to OEM target.	Adjust the system for proper airflow.
t.	Measure and record dry bulb and wet bulb TD across evaporator coil[15].	If DB and/or WB values are outside of appropriate OEM ranges, check for correct airflow, refrigerant charge, and operating conditions.
Refrigeration		
u.	Inspect accessible refrigerant connecting lines, joints, and coils for oil leaks.	Test all oil stained joints for leaks, clean or repair as necessary.
v.	Test reversing valve operation.	Record findings, repair replace as necessary.
w.	If indoor airflow is within OEM specifications but TD is not, check refrigerant charge using manufacturer recommended procedure[16].	Adjust charge as necessary[17].
Closed Loop		
x.	Test pressure of the loop without the unit operating, as applicable.	Add solution or water to meet industry standards.
y.	Test closed loop solution for antifreeze concentration.	Add appropriate antifreeze if needed.
Water Loop (Open or Closed)		
z.	Inspect water pump.	Clean or clear as needed to reduce cavitation and ensure proper operation.
aa.	Confirm correct water flow, and compare to OEM target.	Adjust the system for proper water flow.
bb.	Confirm correct refrigerant charge using superheat or subcooling and compare to OEM target.	Adjust charge as necessary.
cc.	Inspect any screen on source water systems.	Clean or replace as necessary.

[15] This is a minimum standard procedure, and a good diagnostic field practice is to measure superheat or subcooling to ensure proper refrigerant charge.
[16] A good diagnostic field practice is to measure superheat or subcooling to ensure proper refrigerant charge.
[17] Ensure that the metering device (and sensing bulb) is properly installed.

Checklist 5.14-HW Additional Tasks for Hot Water Recovery		
#	**Inspection Task**	**Recommended Corrective Actions**
a.	Measure and record amperage to DHW heat recovery pump.	If outside OEM rating or specification inspect for cause and repair as necessary.
b.	Measure and record TD of water entering and leaving DHW at the heat recovery pump.	Check for improper plumbing or insulation of DHW lines if the water temperature exceeds OEM specifications or local codes.
c.	Measure resistance of 120°F water temperature limit switch.	Replace if shorted or out of OEM specifications.

Checklist 5.15 Evaporative Coolers		
#	**Inspection Task**	**Recommended Corrective Actions**
Cabinet		
a.	Inspect cabinet, cabinet fasteners, and cabinet panels.	Repair or replace insulation to ensure proper operation. Replace lost fasteners as needed to ensure proper integrity and fit/finish of equipment (as applicable). Seal air leaks.
b.	Inspect the required clearance (e.g., service) around cabinet.	Record and report instances where the cabinet does not meet the requirements.
Electrical		
c.	Inspect electrical disconnect box.	Ensure electrical connections are clean and tight. Ensure fused disconnects use the proper fuse size and are not bypassed. Ensure case is intact and complete. Replace as necessary.
d.	Ensure proper equipment grounding.	Tighten, correct and repair as necessary.
e.	Measure and record line voltage.	Compare to OEM specifications or equipment nameplate data. Notify homeowner and/or utility.
f.	Inspect and test contactors and relays.	Look for pitting or other signs of damage. Replace contactors and relays demonstrating evidence of excessive contact arcing and pitting.
g.	Inspect electrical connections and wire.	Ensure wire size and type match the load conditions. Tighten all loose connections, replace heat discolored connections, and repair or replace any damaged electrical wiring.
h.	Inspect motor capacitors.	Replace those that are bulged, split, incorrectly sized, or do not meet OEM specifications.
i.	Measure and record amperage draw to motor/nameplate data (FLA) as available.	If outside OEM rating or specification, inspect for cause and repair as necessary.
Blower Assembly		
j.	Inspect fan belt tension. Inspect belt and pulleys for wear and tear.	Repair or replace as necessary to ensure proper operation (if applicable).
k.	Confirm the fan blade or blower wheel has a tight connection to the blower motor shaft. Inspect fan for free rotation and minimal endplay. Measure and record amp draw.	Lubricate bearings as needed, only if recommended by OEM. If amp draw exceeds OEM specifications then adjust motor speed or otherwise remedy the cause. If due to motor failure recommend replacement of blower motor.
Evaporative Cooling		
l.	Inspect the cooler's bottom pan.	Clean thoroughly or repair.
m.	Inspect water pump.	Clean the pump screen. Remove and foreign material from the hose adaptor. Clean other water pump components as necessary.
n.	Inspect the water distributor manifold and ports.	Flush with water. Repair or replace portions of the manifold, nozzles, or fittings that do not perform per the OEM specifications.
o.	Inspect the evaporative cooling media pads.	Clean scale, dirt, and foreign material from the pads. Replace pads that restrict airflow or do not perform to the OEM specifications.

Checklist 5.16 Accessories		
#	**Inspection Task**	**Recommended Corrective Actions**
Common Cabinet Tasks		
a.	Inspect cabinet, cabinet fasteners, and cabinet panels.	Repair or replace insulation to ensure proper operation. Replace lost fasteners as needed to ensure proper integrity and fit/finish of equipment (as applicable). Clean accessible portions of cabinet interior. Seal air leaks.
b.	Inspect the required clearance (e.g., combustion and service) around cabinet.	Record and report instances where the cabinet does not meet the requirements.
Common Electrical Tasks		
c.	Ensure proper equipment grounding.	Tighten, correct and repair as necessary.
d.	Measure and record line voltage.	Compare to OEM specifications or equipment nameplate data. Notify homeowner and/or utility.
e.	Inspect and test contactors and relays.	Look for pitting or other signs of damage. Replace contactors and relays demonstrating evidence of excessive contact arcing and pitting.
f.	Inspect electrical connections and wire.	Ensure wire size and type match the load conditions. Tighten all loose connections, replace heat discolored connections, and repair or replace any damaged electrical wiring.
g.	Inspect motor capacitors.	Replace those that are bulged, split, incorrectly sized, or do not meet OEM specifications.
h.	Measure and record amperage draw to motor/nameplate data (FLA) as available.	If outside OEM rating or specification, inspect for cause and repair as necessary.
Energy and Heat Recovery Ventilators		
i.	Inspect filters and filter racks.	Clean filters and adjust filter racks as necessary to ensure proper fit and seal of filters per OEM's specifications.
j.	Inspect transfer core.	Wait for core to dry and clean core as necessary.
k.	Inspect fresh air intake vent.	Clear and remove debris to provide to allow for proper airflow.
l.	Inspect fan belt tension. Inspect belt and pulleys for wear and tear.	Repair or replace as necessary to ensure proper operation (if applicable).
m.	Confirm the fan blade or blower wheel has a tight connection to the blower motor shaft. Inspect fan for free rotation and minimal endplay. Measure and record amp draw.	Lubricate bearings as needed, only if recommended by OEM. If amp draw exceeds OEM specifications then adjust motor speed or otherwise remedy the cause. If due to motor failure recommend replacement of blower motor.
Central System Humidifiers		
n.	Inspect humidifier pad.	Replace as necessary.
o.	Inspect water line by gently flexing it and looking for cracks or signs of leakage.	Replace tube if it is cracked, brittle or has been damaged.
p.	Inspect pad tray and frame.	Clean the tray and frame of mineral deposits as necessary.
q.	Inspect drain hose and fitting.	Clean as necessary.
Central System Dehumidifiers		
r.	Inspect for particulate accumulation on filters.	Clean or replace if accumulation results in PD higher than design or airflow is outside of established operating limits.
s.	Inspect air filter housing integrity and air seal.	Correct as needed.
t.	Inspect condensate drain piping (and traps) for proper operation.	Clean, insulate, repair, or replace as necessary.

u.	Inspect drain pan and accessible drain line for biological growth.	Clean as needed to remove bio growth and ensure proper operation, add algae tablets or strips as necessary.
v.	Confirm the fan blade or blower wheel has a tight connection to the blower motor shaft. Inspect fan for free rotation and minimal endplay. Measure and record amp draw.	Lubricate bearings as needed, only if recommended by OEM. If amp draw exceeds OEM specifications then adjust motor speed or otherwise remedy the cause. If due to motor failure recommend replacement of blower motor.
w.	Inspect coil fittings and fins.	Ensure fins are straight and open. Check U-Tubes for signs of refrigerant leaks. Clean and straighten as required.
Electronic Air Cleaners		
x.	Inspect for particulate accumulation on pre-filters.	Clean if accumulation results in PD higher than design or airflow is outside of established operating limits or replace if damaged or inoperable.
y.	Inspect the electrodes or collector plates.	Clean as necessary.
Media Air Cleaners		
z.	Inspect for particulate accumulation on pre-filters.	Replace if accumulation results in PD higher than design or airflow is outside of established operating limits or replace if damaged or inoperable.
Ultra-violet Lights		
aa.	Inspect UV lamps.	Clean or replace to ensure proper operation. UV lamps may contain mercury and must be disposed of properly. Do not throw old lamps into the trash.
Economizers		
bb.	Inspect inlet screen or filter for accumulation, blockage, wear and state of repair.	Clean or replace filters as necessary.
cc.	Inspect minimum position of outside air damper.	Adjust air damper position per design specifications or applicable codes. Repair or replace as necessary.
dd.	Inspect rain hood for proper attachment, security, and signs of water leakage inside the rain hood.	Repair or replace as necessary.
ee.	Inspect actuator motors for free range of motion.	Repair or replace as necessary.
Condensate Pumps		
ff.	Test condensate pump operation and inspect condition.	Clean, flush and test for proper operation.
gg.	Inspect condensate drain piping (and traps) for proper operation.	Clean, insulate, repair, or replace as necessary

APPENDIX A – DEFINITIONS

[This Appendix is not part of the standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ACCA or ANSI.]

access (to): That which enables a device, appliance or equipment to be reached by ready access or by a means that first requires the removal or movement of a panel, door or similar obstruction.

Air Distribution System: The network of plenums, ducts, fittings, grilles, and registers which move air from the house to the HVAC system and then deliver the conditioned air to the house.

Amps (ampere; A): A unit of electric current.

CO: Carbon monoxide, a poisonous, colorless, odorless gas created during incomplete combustion of fossil fuels.

CO_2: Carbon dioxide, a by-product of fossil fuel combustion.

CPH: Cycles per hour, the number of times a unit cycles on and off in one hour.

DHW: Domestic hot water, heated water for domestic use.

ECM: Electronically commutated motor uses electronics to commutate the motor instead of brushes.

ERV: Energy recovery ventilator. Conditions fresh air from outdoors brought into a home while exhausting contaminated air. A special core transfers both sensible (temperature) and latent (moisture) heat from the exhaust air stream to the incoming air stream or visa-versa, depending on the mode of operation (heating or cooling).

FLA: Full load amps, electric current draw of an induction motor under full load.

HRV: Heat recovery ventilator. Conditions fresh air from outdoors brought into a home while exhausting contaminated air. A special core transfers only sensible (temperature) heat from the exhaust air stream to the incoming air stream or visa-versa, depending on the mode of operation (heating or cooling).

HVAC: Heating, ventilating and air conditioning.

inspect: The visual examination and/or taking of appropriate measurements so as to assess a component's physical condition and/or performance of its intended function.

maintain / maintenance: The process of identifying existing or potential faults, coordinating the allocation of resources to correct the faults, and then applying corrective or remedial measures. In an HVAC system, this will support equipment efficiency, promote healthy clean air, watch against unexpected failure, and promote a correct equipment life cycle. This includes terms like inspecting, repairing, servicing, and parts replacement.

maintenance contractors: Appropriately licensed person or persons responsible for maintaining the HVAC equipment. Referred to throughout this standard as the "HVAC contractor."

maintenance program (for residential HVAC): A program which, at regularly scheduled intervals, will systematically inspect, test, measure, and preserve an HVAC system.

metering device: A valve, orifice, or small fixed diameter tubing that meters liquid refrigerant into the evaporator.

MFD (microfarad; *µf*): The capacitance equal to 1/1,000,000 of a farad, which is unit of electric capacitance.

Micron (µm): A unit of measurement equal to 1/1000 of a millimeter. One micron equals .00003936 inches.

OEM: Original equipment manufacturer.

PD: Pressure difference, numerical value determined by subtracting the lower pressure from a high pressure.

RLA: Run or Rated load amps, electric current draw of an induction motor under full load.

reversing valve or four way valve: A valve found in heat pumps that changes the direction of refrigerant flow between heating and cooling cycles.

safety: condition of being safe; freedom from danger or hazard.

test: Engage the operation of a system or a component and compare the results to the manufacturer's specifications or an approved standard.

TD: Temperature difference, numerical value determined by subtracting the lower temperature from a higher temperature.

Water pressure/temperature port: A port used to take pressure or temperature readings, designed to eliminate gauge cocks and thermometer wells

APPENDIX B – EQUIPMENT CAPACITY

[This Appendix is not part of the standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ACCA or ANSI.]

Measuring the equipment's capacity before and after maintenance is performed will enable the field technician to gauge the effectiveness of the work that was carried out. These measurements can also be used to compare the equipment's capacity to previous maintenance visits. However, these measurements may not have been taken prior to the initial implementation of a maintenance program based on this standard, and measuring the equipment's capacity may prove difficult for some practitioners. Therefore, it is not considered a minimum standard requirement, but can be invaluable for ensuring the equipment is operating in an acceptable manner, and for use as a baseline for future maintenance checks.

HEAT EQUATIONS

The following three equations can be used to measure the equipment's total, sensible, and latent capacity:

$$Q_T(Btu/h) = CFM \times 4.5 \times \Delta h$$

$$Q_S(Btu/h) = CFM \times 1.08 \times \Delta T(db)$$

Where:

Q_T is total heat — Q_S is sensible heat

Δh is enthalpy difference — ΔT is dry bulb temperature difference

To calculate the equipment capacity (total, sensible, and latent), the field technician would thus need to make three measurements across the indoor coil or heat exchanger:

1. Volumetric flow rate of air (CFM),
2. Wet bulb temperature difference (to find the enthalpy difference using a psychrometric chart),
3. Dry bulb temperature difference.

Taking these three measurements, and using in the two equations with their respective constants, will allow the field technician to calculate the total and sensible capacity. They can then calculate the latent capacity by simple subtraction ($Q_L = Q_T - Q_S$ or $Q_L = CFM\ x\ 0.68\ x\ \Delta G$).

PERFORMANCE COMPARISON CALCULATION

The field technician can then compare the measured equipment capacity after the maintenance tasks have been completed to its performance prior to maintenance or to any previous capacity measurements, in order to gauge the effectiveness of the maintenance performed.

$$\%\,Change = \frac{Q_{T,new} - Q_{T,old}}{Q_{T,old}}$$

Where:

$Q_{T,\,new}$ is the newest measured total capacity — $Q_{T,\,old}$ is the previous measured total capacity

A negative answer when using this equation indicates deterioration in equipment capacity. The field technician should identify the cause of the deterioration immediately, and make the proper remediation efforts.

ERROR PROPAGATION

One consideration of note is that there is an inherent error in the calculation of in-field equipment capacity, which may limit its effectiveness. This error is inherent because any physical measurement is limited in its accuracy by either the sensitivity of the measurement instrument(s), the specific actions of the measurer (e.g., rounding, measurement locations, etc.), or both. The individual error of each measurement will propagate with use of equations that approximate a physical system. The practitioner must keep this in mind in order to gauge the accuracy of the calculated equipment capacity.

APPENDIX C – HVAC BIBLIOGRAPHY & RESOURCES

[This Appendix is not part of the standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ACCA or ANSI.]

The following documents are offered for informational purposes only and are not considered part of the requirements of this standard. The editions/versions/dates of the documents indicated here are current as of the date of this ACCA standard.

AABC **Associated Air Balance Council (1518 K Street NW, Washington DC 20005; tel: 202/737-0202; www.aabc.com)**

- AABC National Standards for Total System Balance 2002
- AABC Test and Balance Procedures

ACCA **Air Conditioning Contractors of America (2800 Shirlington Road, Suite 200, Arlington, VA, 22206; tel: 703/575-4477; www.acca.org)**

Standards

Manual J	Residential Load Calculation, ANSI /ACCA MJ8 - 2011
Manual D	Residential Duct Systems, ANSI/ACCA 1 Manual D - 2009
Manual S	Residential Equipment Selection, ANSI/ACCA 3 Manual S - 2006
ACCA 5 QI	HVAC Quality Installation Specification, 2010
ACCA 6 QR	Restoring the Cleanliness of HVAC Systems, 2007
ACCA 9 QIvp	HVAC Quality Installation Verification Protocols, 2011
ACCA 12 QH	Existing Home Evaluation and Performance Improvement, 2011

Other Documents

- Manual T, Air Distribution Basics, 1995
- Residential Duct Diagnostics and Repair, 2003
- B. A. Penney, J. E. Woods, and G. C. Hourahan, Good HVAC Practices for Residential and Commercial Buildings: A Guide for Thermal, Moisture and Contaminant Control to Enhance System Performance and Customer Satisfaction, 2003

AHRI **Air Conditioning, Heating and Refrigeration Institute (2111 Wilson Blvd, Suite 500, Arlington, VA, 22201; tel: 703/524-8800; www.ahrinet.org)**

Standards and Guidelines

Standard 210/240	Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment, 2008
Standard 700	Specification for Fluorocarbon Refrigerants, 2011
Standard 740	Refrigerant Recovery/Recycling Equipment, 1998
Standard 880	Air Terminals, 1998
Guideline K	Containers for Recovered Non-Flammable Fluorocarbon Refrigerants, 2009
Guideline N	Assignment of Refrigerant Container Colors, 2012
Guideline Q	Content Recovery and Proper Recycling of Refrigerant Cylinders, 2010

Other

- ARI Product Certification directory/database: ARI certification consists of manufacturers who voluntarily participate in independent testing to ensure that their product will perform according to published claims at specified controlled testing

conditions. Go to http://www.ari.org/standardscert/certprograms/directories/ for more information.
- Industry Recycling Guide (IRG-2), Handling and Reuse of Refrigerants in the US, 1994

ASHRAE **American Society of Heating, Refrigerating and Air-Conditioning Engineers (1791 Tullie Circle, NE., Atlanta, GA; tel: 404/636-8400; www.ashrae.org)**

Standards and Guidelines

Standard 62.2 Ventilation for Acceptable Indoor Air Quality in Low-Rise Residential Buildings, ANSI Approved, 2013

Standard 90.2 Energy Efficient Design of ~~New~~ Low-Rise Residential Buildings, 2007

Other Documents
- L. Harriman, G. W. Brundrett, and R. Kittler, Humidity Control Design Guide for Commercial and Institutional Buildings, 2001

EPA **Environmental Protection Agency Office of Radiation and Indoor Air Indoor Environments Division (6601 J; 1200 Pennsylvania Avenue, N.W. Washington, DC 20460 (202) 343-9370 www.epa.gov/iaq7)**
- §608, Clean Air Act, Stationary Refrigeration and Air-Conditioning, Halon Blends & Handling
- "Should you have the air ducts in your home cleaned," EPA-402-K-97-002, October 1997

IAPMO **International Association of Plumbing and Mechanical Officials (5001 E. Philadelphia Street, Ontario, CA, 91761; tel: 909.472.4100; www.iapmo.org)**
- Uniform Mechanical Code, 2012
- Uniform Plumbing Code, 2012

ICC **International Code Council (500 New Jersey Avenue, NW, 6th Floor, Washington, DC 20001; tel: 888/422-7233; www.iccsafe.org)**
- International Energy Conservation Code, 2012
- International Fire Code, 2012
- International Residential Code, 2012
- International Mechanical Code, 2012
- International Fuel Gas Code, 2012
- International Property Maintenance Code, 2006

IGSHPA **International Ground Source Heat Pump Association (1201 S Innovation Way, Suite 400, Stillwater, OK 74078; tel: 405/744-5175; www.igshpa.okstate.edu)**

IGSHPA develops and publishes a variety of standards for the design and installation of geothermal heat pump ground loops.

NATE **North American Technician Excellence (2111 Wilson Blvd, Suite 510, Arlington, VA, 22203; tel: 703/276-7247; www.natex.org)**

NATE offers certifications tests for service and installation technicians to highlight relevant applied knowledge. Separate 'service' and 'installation' tests are given in the following specialty categories: air conditioning, distribution, air-to-air heat pump, gas heating (air), oil heating (air), hydronics gas, hydronics oil.

NADCA **National Air Duct Cleaning Association (15000 Commerce Parkway, Suite C, Mt. Laurel, NJ 08054; tel: 865/380-6810; www.nadca.com)**

– ACR Standard, 2013 edition: Assessment, Cleaning & Restoration of HVAC Systems

NEBB **National Environmental Balancing Bureau (8575 Grovemont Circle, Gaithersburg, Maryland 20877; tel: 301-977-3698; www.nebb.org)**

– Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems, 2005
– Procedural Standards for Whole Building Systems Commissioning of New Construction, 2009

NFPA **National Fire Protection Association (1 Batterymarch Park, Quincy, MA, 02169; tel: 617/770-300; www.nfpa.org)**

NFPA 31	Standard for the Installation of Oil-Burning Equipment, 2011
NFPA 54	National Fuel Gas Code, 2012
NFPA 58	Liquid Petroleum Gas Code, 2011
NFPA 70	National Electric Code, 2011
NFPA 90a	Standard for the Installation of Air Conditioning and Ventilating Systems, 2012
NFPA 90b	Standard for the Installation of Warm Air Heating and Air-Conditioning Systems, 2012

PHCC **Plumbing-Heating-Cooling Contractors-National Association (180 S. Washington Street, Falls Church, VA, 22046; tel: (703) 237-8100; www.phccweb.org)**

– Heating and Cooling Technical Manual
– Variable Air Volume Systems

RSES **Refrigeration Service Engineers Society (1911 Rohlwing Road, Suite A, Rolling Meadows, IL, 60008; tel: 847/297-6464; www.rses.org)**

Various training manuals, self-study courses, classes and CDs to enhance the professional development of practitioners within the refrigeration sector.

SMACNA **Sheet Metal and Air Conditioning Contractors' National Association (4201 Lafayette Center Drive, Chantilly, VA, 20151; tel: 703/803-2980; www.smacna.org)**

– Fibrous Glass Duct Construction Standards, 2003
– HVAC Air Duct Leakage Test Manual, 2012
– HVAC Duct Systems Inspection Guide. 2006
– HVAC Duct Construction Standards, Metal and Flexible, 2005
– HVAC Systems Commissioning Manual. 1994
– HVAC Systems Testing, Adjusting & Balancing. 2002

UL **Underwriters Laboratories Inc., (333 Pfingsten Road, Northbrook, IL 60062; tel: 847/272-8800; www.ul.com)**

Standards

UL 181	Standard for Safety Factory-Made Air Ducts and Air Connectors, 1996
UL 181A	Standard for Safety Closure Systems for Use with Rigid Air Ducts and Air Connectors, 2nd edition, 1994
UL 181B	Standard for Safety Closure Systems for Use with Flexible Air Ducts and Air Connectors, 1995

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