



ACCA Standard 4

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Maintenance of Residential HVAC Systems

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

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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 possess 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 contractors¹, 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 equipment², 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 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

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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.

CO₂: 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

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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:

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

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

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 $Q_L = \text{CFM} \times 0.68 \times \Delta G$).

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.

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

Where:

$Q_{T, \text{new}}$ is the newest measured total capacity

$Q_{T, \text{old}}$ 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

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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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