



# Verifying CAZ Safety: ACCA Standard 12

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## Agenda

- Introductions
- HERS Industry
- HERS Ratings
- ACCA Standard 12
- Resources

**ACCA**  
AIR CONDITIONING  
CONTRACTORS OF AMERICA

2800 Shillington Road  
Suite 300  
Arlington, VA 22206  
703.576.4477  
Fax 703.576.1107  
www.acca.org

**ACCA Standard 12**  
STANDARD NUMBER: ANSI/ACCA 12-0H-2011

**Existing Home Evaluation and Performance Improvement**  
Residential One- and Two-Family Dwellings and Townhouses Not More Than Three Stories Above Grade.

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

Developed in cooperation with the Residential Energy Services Network

**RESNET**  
Energy Efficiency & Quality

**ANSI**  
www.ansi.org

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## About Me

**KSG** Kruger  
Sustainability  
Group

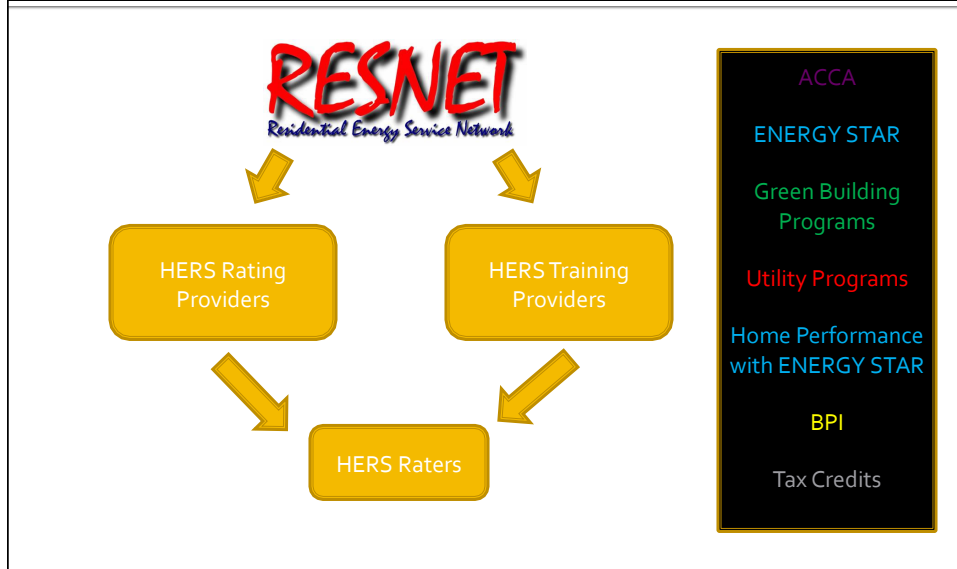
- HERS Rater & Trainer/QAD
- BPI Building Analyst & Proctor
- LEED AP Homes & ND
- LEED Green Rater
- EarthCraft Technical Advisor
- Educator
- Curriculum development
- Member RESNET Technical Committee
- Utility DSM Program Design & Implementation



## Introductions

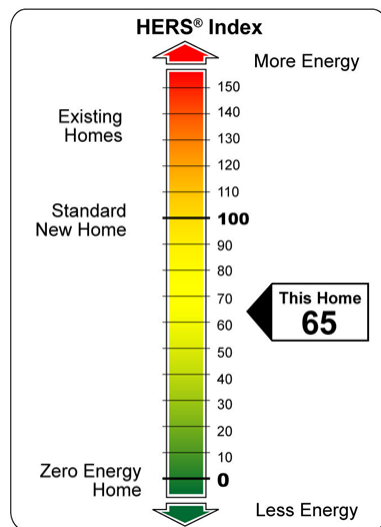
- Audience
  - HERS Raters?
  - Code officials?
  - HVAC contractors?
  - Insulators?
  - Architects?
  - Government employees?
  - Where from?

## HERS industry




## HERS Ratings

- HERS Index accounts for:
  - Heating
  - Cooling
  - Water Heating
  - Lights
  - Appliances



# HERS Rating is the Home's Mileage



**5 Stars**  
Confirmed Rating

**HERS Index: 81**

Conditioned Area: 4796 sq. ft.  
Conditioned Volume: 41054 cubic ft.  
Basement: ✓

House Type: Single-family detached  
Foundation: Conditioned basement

**Mechanical Systems Features**

Heating: Fuel-fired air distribution, Natural gas, 92.1 AFUE  
Cooling: Air conditioner, Electric, 13.0 SEER  
Duct Leakage to Outside: 28.25 CFM  
Ventilation System: None  
Programmable Thermostat: Heating: Yes, Cooling: Yes

**Building Shell Features**

Ceiling/Floor: U-0.040, R-38  
Walls: R-19, R-13  
Foundation: R-24, R-10  
Slab: R-5.0 Edge, R-0.0 Under

**Lighting and Appliance Features**

Percent Fluorescent Fixtures: 10.00  
Percent Fluorescent CFL: 0.00  
Refrigerator (ENERGY STAR): 778.00  
Dishwasher Energy Factor: 0.46

Clothes Dryer Fuel: Electric  
Range/Oven Fuel: Natural gas  
Cabinet Fan (if any): 0.00


The Home Energy Rating Standard Certificate for this home is available from the rating provider.  
HERS Index - Residential Energy Analysis and Rating Software v12.4.0  
This information does not constitute any warranty of energy cost or savings.  
A full report is available from the rating provider.

Rating Number: 12387-01  
Certified Energy Rater: Lee O'Neal  
Rating Date: December 26, 2007  
Rating Obtained For: Stanley Martin Custom Homes

Use	MMBtu	Cost	Percent
Heating	77.8	\$272	15%
Cooling	11.3	\$396	15%
Hot Water	19.8	\$80	4%
Lights/Appliances	58.9	\$148	8%
Photovoltaics	0.0	\$0	0%
Service Charges		\$232	11%
<b>Total</b>		<b>\$2309</b>	<b>100%</b>

**This home meets or exceeds the minimum criteria for all of the following:**  
EPA Energy Star Home  
ASHRAE Standard 90.2 - 1990  
2003 International Energy Conservation Code  
2004 International Energy Conservation Code  
2006 International Energy Conservation Code

N5pects Inc.  
P.O. Box 221704  
Charlottesville, VA 22913-1704  
703-574-4365  
703-836-5216



Compare this vehicle to others in the FREE FUEL ECONOMY GUIDE available at the dealer.

**CITY MPG: 14**

**Fuel Mileage Information**

**HIGHWAY MPG: 19**

Actual Mileage will vary with options, driving conditions, along with load and vehicle condition. Results reported to EPA indicate that the majority of vehicles with these estimates will achieve between 11 and 17 mpg in the city, and between 16 and 22 mpg on the highway.

Estimated Annual Fuel Cost: \$1152

Compare this vehicle to others in the FREE FUEL ECONOMY GUIDE available at the dealer.

**CITY MPG: 23**

**Fuel Economy Information**

**HIGHWAY MPG: 30**

Actual Mileage will vary with options, driving conditions, along with load and vehicle condition. Results reported to EPA indicate that the majority of vehicles with these estimates will achieve between 19 and 27 mpg in the city, and between 25 and 35 mpg on the highway.

Estimated Annual Fuel Cost: \$850

# HERS Ratings

- HERS Ratings consists of
  - Building components
  - Envelop leakage
  - Duct leakage
  - Software modeling
  - Reporting
  - **Combustion safety**

Based on standard U.S. Government tests

## ENERGYGUIDE

Water Heater - Natural Gas  
Capacity (first hour rating): 57 Gallons

GSW Water Heating Company  
Model: JWS458NA  
#4450

**Compare the Energy Use of this Water Heater with Others Before You Buy.**

This Model Uses **268** therms/year

Energy use (therms/year) range of all similar models

Uses Least Energy: 238  
Uses Most Energy: 273

Therms/year is a measure of energy use. Your utility company uses it to compute your bill. Only models with first hour ratings of 56 to 64 gallons are used in this scale.

Natural gas water heaters that use fewer therms/year cost less to operate. This model's estimated yearly operating cost is: **\$162**

Based on a 1994 U.S. Government national average cost of \$0.604 per therm for natural gas. Your actual operating cost will vary depending on your local utility rates and your use of the product.

Important: Removal of this label before consumer purchase is a violation of Federal law (16 U.S.C. 2602).

## But What about Combustion Safety?

New & Existing Construction



## Combustion By-Products

- Heat
- Light
- Nitrogen Oxides (NO<sub>x</sub>)
- Water/water vapor (H<sub>2</sub>O)
- Carbon Dioxide
- Carbon Monoxide

## Carbon Monoxide

- Carbon Monoxide (CO) is a colorless, odorless, and tasteless gas which results from combustion of fuels.
- Carbon monoxide results from “incomplete combustion” in the appliance
- This happens when there is an improper air/fuel mixture
- Oxygen deprivation can occur when burner flames impinge on a solid surface

## Potential Health Effects of Carbon Monoxide Exposure

- **At low concentrations:** Shortness of breath, mild nausea, mild headaches
- **At moderate concentrations:** Impaired vision and coordination, headaches, dizziness, confusion, nausea, and flu-like symptoms
- **At very high levels:** Can be fatal, causing death within minutes

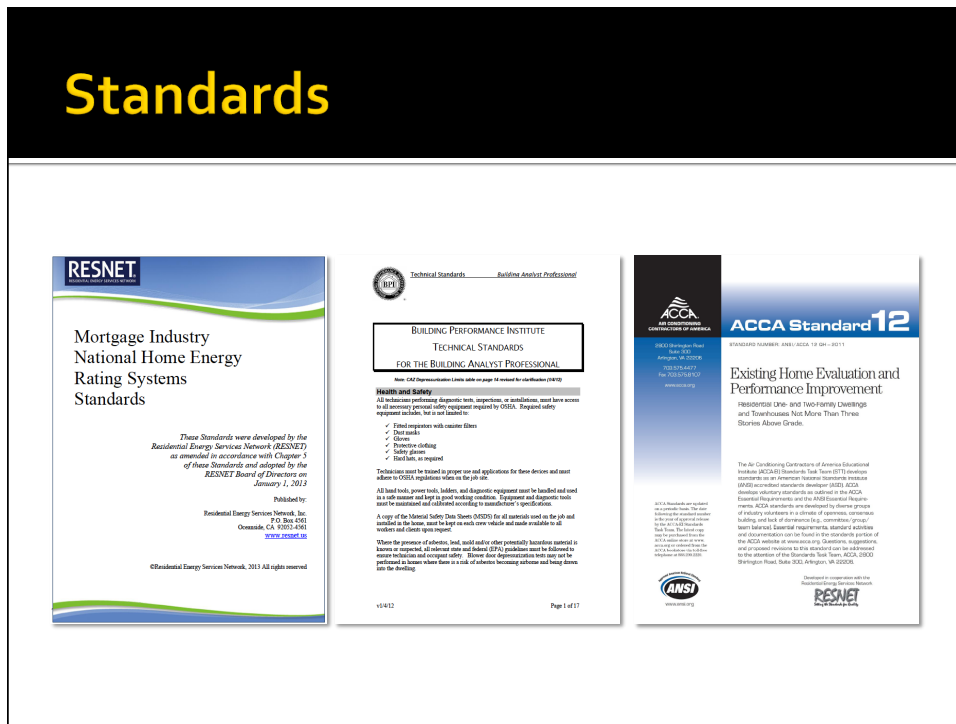
## Long Term Carbon Monoxide Exposure

- Long term exposure at low levels, can cause:
  - Headache, nausea, vomiting, muscle pain, joint pain, chronic fatigue, dizziness, numbness, tingling, and vertigo, as well as:
  - Cognitive / Memory Impairments
  - Affective Disorders (emotional/personality effects)
  - Sensory and Motor Disorders

## Venting Combustion Appliances

- Venting moves combustion gases to the outside
- Prevents overheating of the appliance
- Prevents condensation damage to appliances and vents

# Standards



# HERS Standards

- Chapter 7: Home Energy Audits
- Chapter 8: Performance Testing & Work Scope
  - Building enclosure air tightness testing
  - Duct leakage testing
  - Ventilation airflow testing
  - Gas leakage testing
  - Worst case depressurization testing
  - Carbon monoxide testing
  - Work scope for contractors



## ACCA Standard 12 QH - 2011

- Purpose
  - Establish minimum criteria by which deficiencies in existing residential buildings are identified by audit, improvement opportunities are assessed, scopes of work are finalized, work is performed in accordance with industry recognized procedures, and improvement objectives were met.
- Scope
  - Applies to existing site-constructed or manufactured one- and two-family dwellings and townhouses not more than three stories above grade in height.

### 3.1 – Interview

- Conduct interview to identify occupant behaviors and use patterns that impact energy use, occupant perceived problems and concerns relating to energy use.
- Use interview questions in Appendix A.



Source: DSB Energy Services

## 3.2 – On-Site Data Collection

- Record the following
  - R-values & location of wall/ceiling/floor insulation
  - Square footage, volume, and age of home
  - Windows
  - HVAC equipment and distribution system
  - Foundation type
  - Lights & appliances
  - Durability issues

## 3.3 – Health & Safety: Fossil Fuel Appliances

- 3.3.1 – CO testing
- 3.3.2 – Gas/Oil leakage testing
- 3.3.3 – Unvented combustion appliances
- 3.3.4 – CAZ volume
- 3.3.5 – Depressurization test (atmospherically vented appliances)
- 3.3.6 – Combustion Appliance Venting (atmospherically vented appliances)

### 3.3.1 – CO testing

- Measure and record CO levels in:
  - Combustion appliance flue gases
  - Accessible venting systems
  - Combustion appliance zone (CAZ)
- Acceptable Procedures
  - Appendix A
  - RESNET Standards
  - BPI Standards

### CO Measuring Equipment

- Equipment used to measure CO shall:
  - Measure (CO) levels from 0 to 2,000 ppm
  - Resolution of 1 ppm
  - Visual readout
  - Accuracy rate of + 5%
  - Calibrated annually by the manufacturer and have evidence of the calibration.

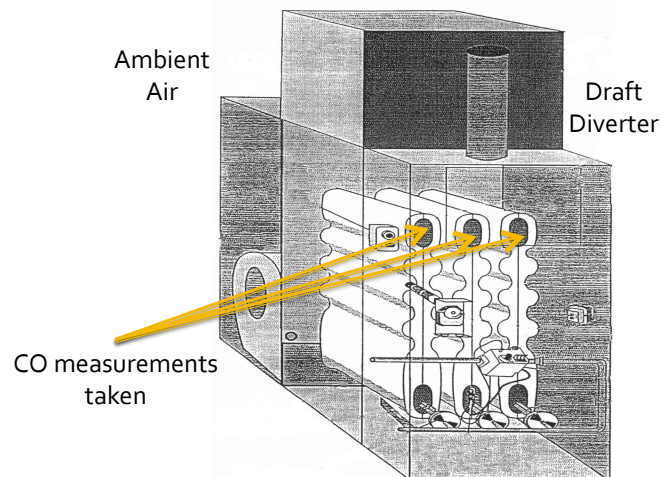
## CO Monitoring

- Measure the outdoor CO level, use as baseline.
- Run CO measurement equipment continuously.
- If CO levels of 9 ppm are detected for more than 15 minutes, then the Auditor has the discretion to stop all CO testing and depressurization testing.
- If CO levels of **25 ppm** are detected, stop all CO testing and depressurization testing.

## Atmospherically Vented Appliances

- For atmospherically vented appliances:
  - Take a measurement of combustion gases at the flue before the draft diverter and around the external perimeter of accessible vent piping joints.
  - Appliance must operate for at least 5 minutes before taking sample.
  - Take sample during depressurization test.

## Where to Test for Undiluted CO

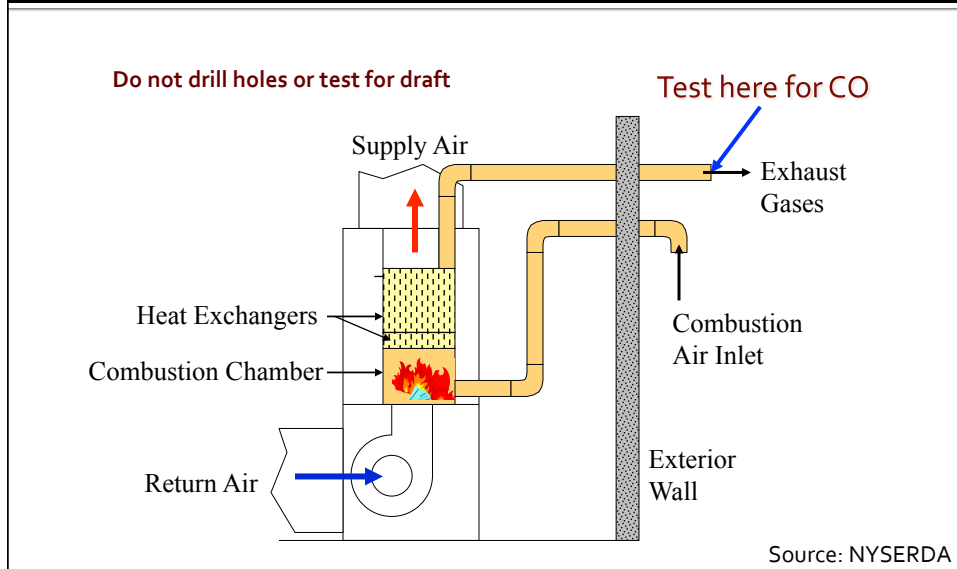


Source: NYSERDA

## Direct Vented Appliances

- For direct vented appliances:
  - Sample must be taken at vent connection and around the external perimeter of accessible vent piping joints
  - Appliance must operate for at least 5 minutes before getting sample
  - Take sample during depressurization test

## Undiluted CO Measurement in a Power Vented Furnace



## Gas Ovens

- Open a window or door to the outside
- Remove any foil or cooking utensils within the oven
- Verify that the oven is not in self-cleaning mode
- Turn oven on to highest temperature setting
- Close the oven door and monitor CO levels in the kitchen
- Measure the CO levels within the oven vent.
  - Samples must be taken while burner is firing.
  - Operate burner for at least 5 minutes, or per OEM instructions
  - Record the lowest CO reading in ppm and turn off oven.



## Ovens: Action Levels

- If CO levels are  $\geq 100$  ppm or an appliance fails to meet manufacturer's benchmarks for CO production:
  - Notify the client of the need to call a qualified technician to have the appliance repaired/tuned.
  - Do not perform air sealing measures on the home.
- If CO levels are  $\geq 300$  ppm:
  - Document that the equipment is unsafe for continued operation.
  - Document that the client was informed of this condition.
  - Do not perform air sealing measures on the home.

## 3.3.2 – Gas/Oil leakage testing

- Verify that all accessible exposed gas/oil piping in the building has been inspected for leaks, and leak locations have been identified.
- If gas odor, everyone must evacuate and notify the appropriate authorities and utility providers.
  - Ensure that switches are not operated while exiting and no ignition sources are present.
  - The audit shall not proceed until the proper authorities have deemed it safe to re-enter the building.

## Gas/Oil Leak Detection

- Gas lines:
  - Inspect all fittings and joints in supply lines and appliances with the appropriate gas detector capable of measuring 20 ppm.
  - Confirm measured leaks with leak-detection fluid.
- Oil lines shall be visually inspected for oil.



## 3.3.3 – Unvented combustion appliances

### 3.3.3 Unvented Combustion Appliances

- a. Requirement: The Auditor shall record the presence, location, and input rating of unvented combustion appliances and if listed to ANSI Z21.11.2.
- b. Acceptable Procedures: The Auditor shall confirm that the information required is properly recorded.

ANSI Z21.11.2: Gas-Fired room heaters Volume II, unvented room heaters



### 3.3.4 – CAZ volume

- Measure the volume of the space or openings providing combustion air to fossil fuel appliances.
- Acceptable Procedures:
  - National Fuel Gas Code §9.3, or
  - Authority having jurisdiction (AHJ).

### 3.3.5 – Depressurization test (atmospherically vented appliances)

- Provide evidence that the combustion appliance is installed in a safe condition for continuing use during periods of depressurization generated by the occupants.
- Acceptable Procedures:
  - Appendix A
  - CAN/CGSB 51.71-2005
  - Original Equipment Manufacturer (OEM) specified procedure
  - AHJ (e.g., IRC APPENDIX D)
  - RESNET Standards
  - BPI Standards

## Depressurization Test ("worst-case")

- Close exterior windows & doors
- Turn on all indoor exhaust fans
- Open/close interior doors to achieve the highest pressure differential in the CAZ room with reference to (wrt) the outdoors.
- Turn on smallest Btu input appliance
- Test for spillage
- If multiple appliances in CAZ, turn on next one

## Spillage Test

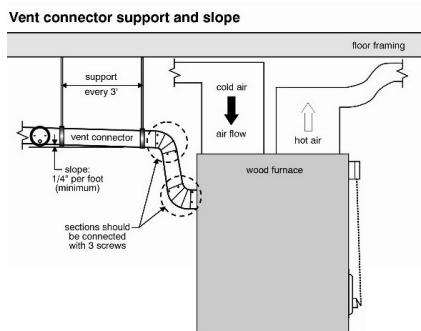


Source: NYSERDA

### 3.3.6 – Combustion Appliance Venting (atmospherically vented appliances)

- Record evidence that the combustion appliance vent exhaust system is installed incorrectly.
- Inspect the vent exhaust system and record the presence of the following:
  - Blockages
  - Soot
  - Corrosion or oxidation
  - Proper support, slope and termination

## Visual Assessment



Evidence of Spillage and Improper Draft

Source: NYSERDA

## 3.4 – Envelope leakage

- Perform blower door test
- Acceptable Procedures
  - Appendix A
  - RESNET Standards



Source: Southface

## 3.5 – Ventilation

- Determine the minimum ventilation requirement for the occupants of the building (in accordance with ASHRAE 62.2 – 2010).
- The mechanical ventilation airflow shall be measured.
- Verify that exhaust fans and clothes dryers vent to outdoors.

## 3.6 – Insulation

- Determine the insulation levels in the applicable building components (walls, ceilings, roofs, floors, slabs, and crawlspaces).
- Assign insulation grade in accordance with RESNET Standards.

## 3.7 – Heating & cooling systems

- 3.7.1 – Validation of capacity to load
- 3.7.2 – Airflow testing
- 3.7.3 – Distribution System Temperature Difference
- 3.7.4 – Room temperature difference
- 3.7.5 – Duct leakage testing
- 3.7.6 – Room-pressure differences

## 3.8 – Water Heating

- The Auditor shall determine:
  - Name plate efficiency and age of the water heater(s)
  - Hot water piping insulation R-value

## 3.9 – Fenestration

- Determine the following in accordance with RESNET Standards:
  - U-values and solar heat gain coefficients (SHGC) for glazing components (windows, glass doors, skylights, etc.)
  - Existing shading (overhangs, awnings, etc.).

## 3.10 – Appliances and Equipment

- Identify appliances and equipment that can be replaced with those that are more energy efficient.

Table 1: Appliances rated by ENERGY STAR

Appliances	Computers & Electronics	Lighting and Fans
Clothes Washers	Audio/Video	Decorative Light Strings
Dehumidifiers	Computers	Fans, Ceiling
Dishwashers	External Power Adapters	LED Light Bulbs
Freezers	Imaging Equipment	Light bulbs (CFLs)
Refrigerators	Set-top Boxes & Cable Boxes	Light Fixtures
	Televisions	Residential LED Lighting

## 3.11 – Plumbing Fixtures

- Visually inspect plumbing fixtures
  - Measure water flow rates
  - Identify the fixtures that would benefit from being upgraded to meet EPA's WaterSense specifications.



## 3.12 – Moisture

- The building shall have systems to prevent damage from rain and ground water.
- Any existing interior or exterior moisture issues need to be identified for remediation prior to air sealing and/or further insulating the building shell.

## 3.13 – Pools and Spas

- The Auditor shall ensure:
  - **Safety:** Note type of suction outlet cover(s) and flow rating.
  - **Motor efficiency:** Record the total horsepower of the pump motor, type of controls, and timers being used for the pool or spa.
  - **Heated pools:** Record the type of pool heater, the water temperature, the location of the heater's on-off switches, if switch



## 3.14 – Documentation

- The audit file includes
  - Data (e.g., measurements, observations, test results, etc.) for each specified building audit requirement, a record of the model and serial numbers of all equipment audited, supporting measurements, and/or calculations.
  - Additional information applicable to the audit activity undertaken (drawings, photographs, etc.).
  - Copies of documents from §3.14.1.1, including the modeling software file, are maintained at the Auditor’s place of business.

## Assessing Improvements

Improvement Area	Current measurement or value	Comparative Benchmarks
§3.3.1 CO of flue gasses	_____ ppm	< 100 ppm
CO at vent piping	_____ ppm	0 ppm (i.e., no leaks)
Ambient CO level in CAZ	_____ ppm	Less than 9 ppm
CO of undiluted flue gasses	_____ ppm	As specified by EPA Air Quality Criteria for Carbon Monoxide (EPA 600/P-99/001F 2000)
§3.3.2 Gas/Oil Leakage Testing	Leaks located at _____ _____	No leaks
§3.3.3 Unvented Combustion Appliances	Appliance(s) present _____ Location(s) _____ Input rating(s) _____ Listed to ANSI Z21.11.2 Yes/No	Listed per ANSI Z21.11.2
§3.3.4 CAZ Volume	Measured volume of combustion air: _____ ft <sup>3</sup> Measured area of combustion air openings: _____ ft <sup>2</sup>	As specified by the IRC 2009, §G2407
§3.3.5 Depressurization	Appliance displays proper draft all of the way around the appliance. Yes/No or Pressure in CAZ _____ Pa	Appliance drafts at all points around the circumference of the draft hood relief opening  Positive or neutral pressure in the CAZ

## Cost/Benefit Analysis

- Cost benefit analysis computed using:
  - DOE 2.0 (BEOPT<sub>2</sub>)
  - RESNET accredited software
  - ACCA recognized software
  - The AHJ

## Resources

ACCA  
[www.acca.org](http://www.acca.org)

BPI  
[www.bpi.org](http://www.bpi.org)

RESNET  
[www.resnet.us](http://www.resnet.us)



# Thank You!

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