



State of Ohio
Weatherization Program
Standards

Section	DIAGNOSTIC TESTING METHODS
Subject	Heating Unit Safety and Efficiency

HEATING UNIT SAFETY AND EFFICIENCY 1506-8

The following is a set of procedures to complete a safety and efficiency inspection of a combustion heating and DHW system. These procedures are based on the standards set by NFPA 31, 54, 211, and ANSI Z21.

PREPARATION 1506-8.1

Using a calibrated gas leak detector, test all gas lines between the gas meter and all gas appliances. It is recommended that gas leak detection be done as early as possible in the inspection process.

detect leaks
1506-8.1a

Perform a visual inspection of venting, wiring, piping and ductwork. From the furnace and DHW identification plates, record model numbers, rated Btu inputs, etc.

visual inspection
1506-8.1b

Measure the dimensions of the space from which the heating system and DHW unit take their combustion air. Ensure that this is an UNCONFINED space: Add up the Btuh input of all of the gas appliances in that space. NFPA 54 requires a minimum of 50 cubic feet of space for each 1000 BTUh of appliance input. A CONFINED space requires direct communication with additional combustion air from outside the space.

measure CAZ
1506-8.1c

Drill test holes in the flue pipes, return plenum, and in a supply duct at a point six inches downstream of the supply plenum.

test holes
1506-8.1d

Locate the test hole 1 1/2 times the diameter of the flue away from an elbow or flue collar.

test hole location
1605-8.1e

Calibrate the combustion analyzer PMI.

calibrate analyzer
1506-8.1f

Note: If a gas DHW unit shares a chimney with a gas heating unit, test the DHW unit first. An underheated, oversized chimney presents a hazard to establishing DHW unit draft. At all costs, a continuously backdrafting DHW unit must be remedied.

DHW INSPECTION PROCEDURES 1506-8.2

worst case draft test 1506-8.2a	Perform a worst case draft test on the DHW (see 1506-4).
combustion efficiency test 1506-8.2b	Start the efficiency test. Use the flue gas temperature to determine when the unit reaches steady-state.
CO and combustion 1506-8.2c	At steady-state, record the CO and combustion test readings.
clock meter 1506-8.2d	Ensuring that no other gas appliances are firing, clock the gas meter. A reading of $\pm 10\%$ of the rated input is acceptable.
pilot safety drop-out test 1506-8.2e	Perform a safety drop-out test on the DHW unit gas control valve. After the DHW unit has been firing for at least 10 minutes, turn the control knob to pilot, extinguish the pilot flame, time how long it takes for the safety valve to close. Use a calibrated gas leak detector to verify that gas is not leaking through the main gas supply valve. Three minutes or less is acceptable. Keep the gas shut off. For oil units check the primary control and cad cells.
main valve safety drop-out test 1506-8.2f	Perform a safety drop-out test on the main gas valve of the gas control valve. Turn the gas back on at the manual shut-off valve. Use a gas detector to ensure that the main gas valve has remained closed. If gas is detected, the gas valve is not safe and will need to be replaced.
relight pilot 1506-8.2g	Relight the pilot and ensure that the DHW unit is operating properly.
visual inspection 1506-8.2h	Visually inspect the combustion chamber for rust, dirt and proper burner alignment. Visually inspect venting, plumbing and gas piping. Check the tank for water leaks and note any NFPA or WPS violations.
temperature setting 1506-8.2i	Consult the occupant on the desired water temperature setting. Adjust the setting accordingly, setting it no lower than 120° F and no higher than 140° F.

FURNACE INSPECTION PROCEDURE 1506-8.3

shut off power 1506-8.3a	Shut off the power to the furnace. Use a non-contact voltage detector to confirm that the power to the unit has been shut off.
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Remove the thermostat and hook up an anticipator meter.	hook up meter 1506-8.3b
Turn the power on and fire the unit.	turn power on 1506-8.3c
Perform a draft test if applicable. If draft is not established at two (2) minutes, note it on the work order and continue (see 1506-4).	perform draft test 1506-8.3d
If at two (2) minutes the furnace backdrafts CO into the ambient air, stop the inspection, shut down the furnace, find the cause of the backdrafting and have the draft problem corrected.	
Start the combustion efficiency test PMI for the type of analyzer being used. Monitor the flue gas temperature for steady-state.	combustion efficiency test 1506-8.3e
When the unit reaches steady-state, perform a combustion efficiency test in each burner exhaust port for gas units, and before the barometric damper for oil or induced draft unit. If the CO or O ₂ fluctuates after the blower fan comes on, this may indicate a cracked heat exchanger.	test 1506-8.3f
Measure the temperature in a hole drilled in a supply duct within 12 inches of the supply plenum. Return temperature may be taken in the return plenum or at the filter compartment. Calculate the temperature rise across the heat exchanger by subtracting the return air temperature from the supply air temperature. Compare this ACTUAL temperature rise to the RATED temperature rise indicated on the furnace ID plate (or within the acceptable range of 60 F and 90 F). A discrepancy between the rated and the actual temperature rises can be a good indicator of air flow-related problems within the distribution system.	temperature rise 1506-8.3g
Ensuring that no other gas appliances are firing, clock the gas meter. Plus or minus 10% from the rated input is acceptable for atmospheric appliances. Condensing appliances must be within plus or minus 4% (or PMI). For oil units, verify that the nozzle size is as rated on the data plate. For electric units, verify that all heating elements are working in sequence.	clock meter 1506-8.3h

pilot safety drop-out test

1506-8.3i

Perform a safety drop-out test on the gas control valve. After the unit has been firing for at least 10 minutes, turn the control knob to pilot, extinguish the pilot flame, and time how long it takes for the safety valve to close. Use a calibrated gas leak detector to verify that gas is not leaking through the main gas supply valve. Three minutes or less is acceptable. Keep the gas shut off. For oil units, check the primary control and cad cell.

main valve safety drop-out test

1506-8.3j

Perform a safety drop-out test on the main gas valve of the gas control valve. Turn the gas back on at the manual shut-off valve. Use a gas leak detector to ensure that the main gas valve has remained closed. If gas is detected, the gas valve is not safe and will need to be replaced.

relight pilot

1506-8.3k

Relight the pilot and ensure that the furnace is operating properly.

shut off power

1506-8.3l

Shut off power to the furnace and use a non-contact voltage detector to verify that the power is off.

test limit control

1506-8.3m

With the power to the furnace shut off, disconnect one wire from the fan control, or from the fan side of a fan/limit control; or remove the fan belt, or block off all return registers. Insert the temperature probe in the supply duct test hole and turn the power on. Monitor the supply air temperature as the furnace heats up. Compare the temperature at which the limit control shuts off the burners or elements to the temperature at which the limit is set. Plus or minus 10% is the acceptable range.

shut off power

1506-8.3n

Shut off the power to the unit and verify that the power is off. Reconnect the fan wire (or put the fan belt back on, or unblock the return registers). Turn the power on.

visual inspection

1506-8.3o

Visually inspect the interior of the heat exchanger with a mirror and flashlight. Verify any suspected cracks with an AGA-approved testing method.

worst case draft test

1506-8.3p

As a final precaution, perform a worst case draft test on the furnace and the DHW together (see 1506-4)

adjust anticipator

1506-8.3q

Measure the amp draw at the thermostat. Adjust the anticipator or specify adjustment on the work order. Reconnect the thermostat, making sure it is level.

Note 1: If a humidifier and/or an electronic air cleaner are controlled by the same 24 volt circuit as the furnace, those units must also be running when the amp draw on the 24 volt circuit is measured.

Note 2: If an adjustment is made to the anticipator, run the furnace through one cycle to ensure proper cycling.