Carbon Monoxide and Combustion Testing Procedures

It is vitally important to discover and work within the local Authority of Jurisdictions standards for CO concentration limits in flue gas. All concentrations are referenced to a steady-state or stabilized condition of the systems operation with combustion gas sampling points before the draft hood of an appliance or other entries of dilution air.

<100 ppm CO air free

Gas furnaces, space and water heaters are usually considered safe and left in operation.
Annual test: It is reported to be as low as 25 PPM in some weatherization programs. The more testing performed, the more the technician understands what is achievable and reasonable.

<150 ppm CO air free

Common ceiling concentration for unvented gas oven emission. Repair recommended if over this amount.

100 - 400 ppm air free

Gas furnaces, space, water heaters and boilers require further testing and correction. Not necessarily immediately lethal concentrations of CO but conditions generally found to be correctable within parameters of normal service work. Systems are generally left in operation with set time limits for corre

400+ ppm air free

Frequently, gas systems are shut off and/or corrected when concentrations exceed this concentration.

Carbon Monoxide Sample Locations

The measurement for gases and temperature should be taken at the same point. Typically, this is done by selecting a sample location ‘upstream’ from the draft diverter/hood, barometric control or any other opening, which allows room air to enter and dilute flue gases in the stack. In larger installations it may also be necessary to extract a number of samples from inside the flue to determine the area of greatest flue gas concentration. Another common practice is to take the flue gas sample from the ‘Hot Spot’ or the area with the highest temperature.

Make sure that the sample point is before any draft diverter/hood or barometric damper so that the flue gasses are not diluted.

The sample point should also be as close to the breach area as possible. This may also provide a more accurate CO reading should air be entering the flue gas stream through joints in sheet metal vent connectors

Oil Burners

Locate the sampling hole at least six inches upstream from the breech side of the barometric control and as close to the boiler breeching as possible. In addition, the sample hole should be located twice the diameter of the pipe away from any elbows.

Gas Burners

Locate the sampling hole on power burner fired boilers/forced air units at least six inches upstream from the breech side of any double acting barometric control and as close to the boiler breeching as possible. Again, try to stay away from elbows. When testing atmospheric equipment with a draft diverter/hood, the flue gas sample should be taken inside the port(s) where flue gases exhaust the heat exchanger.

When testing atmospheric, forced air heating equipment with a clamshell or sectional heat exchanger design, test each of the exhaust ports at the top of the heat exchanger. The probe should be inserted back into each of the exhaust ports to obtain a flue gas sample, before any dilution air is mixed in.

IN ALL Cases -- CO testing should also be conducted around the burner area

Draft tests should be taken from a hole drilled in the stack downstream from the draft hood.

Combustion and draft testing fan assist (80%), furnaces/boilers should be done through a hole drilled in the vent immediately above the inducer fan.

Condensing furnaces/boilers can be tested through a hole drilled in the plastic vent pipe (when allowed by the manufacturer or ‘local authority of jurisdiction) or taken from the exhaust termination.

It is important to remember that the vent system on these units operates under a positive pressure. As a result, any holes in the vent need to be sealed.

If the furnace/boiler is not a ‘sealed system’ (which draws combustion air through a pipe from the outside) and the burners are open, CO testing should also be conducted around the burner area.

Domestic hot water heaters with the ‘bell’ shaped draft diverter on top can be accurately tested by attaching a section of copper tubing to the probe or using a flexible probe which is then inserted directly into the top of the fire tube below the diverter.

Another common practice is to insert the probe in the hole drilled for the draft test, direct it down and push it below the level of the draft hood.

When testing boilers with a draft diverter mounted on the back of the equipment, flue gas samples should be taken by passing the probe from one side to the other, again upstream (toward the burner) from the opening into the draft diverter.

Boilers/forced air units, which have a ‘bell’ shaped draft diverter directly on top, should be tested directly below the diverter through a hole drilled in the vent connector.

It is also a good idea to test any areas with openings that provide a path for combustion air to be introduced to the flame. These areas provide a path where flue gases can potentially be exhausted.

With forced air systems this area is generally limited to immediately in front of the burners while many styles of boilers allow secondary combustion air to also be drawn in from all around the base of the cabinet.

Fuel oil and gas fired power burners equipped with barometric controls require CO tests be taken at least 6” up stream from the barometric, close to the breeching.

When testing (primarily commercial/ industrial) equipment with modulating or multiple firing rates, it is critical that tests are performed throughout the entire firing range. Typically, larger burners begin to fire at a reduced firing rate to ensure a safe, reliable light off. Once ignition has been proven, air and fuel controls open to the full rated firing capacity of the boiler.

Once the call for heat has been satisfied, the firing rate is slowly reduced to a minimum position before the cycle ends and the flame is extinguished. Failing to test throughout the entire cycle of burner operation may not identify a particular point at which excess levels of CO are produced.