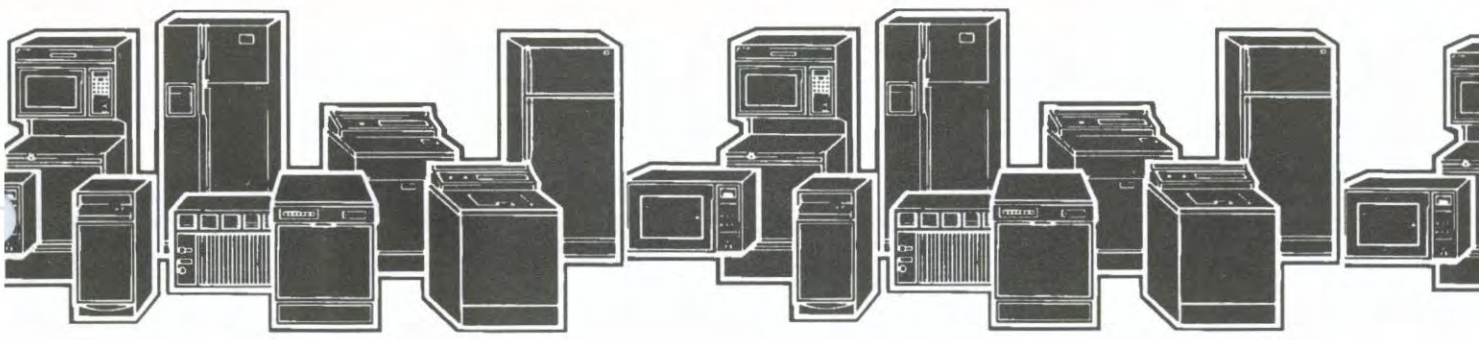
Whirlpool CORPORATION

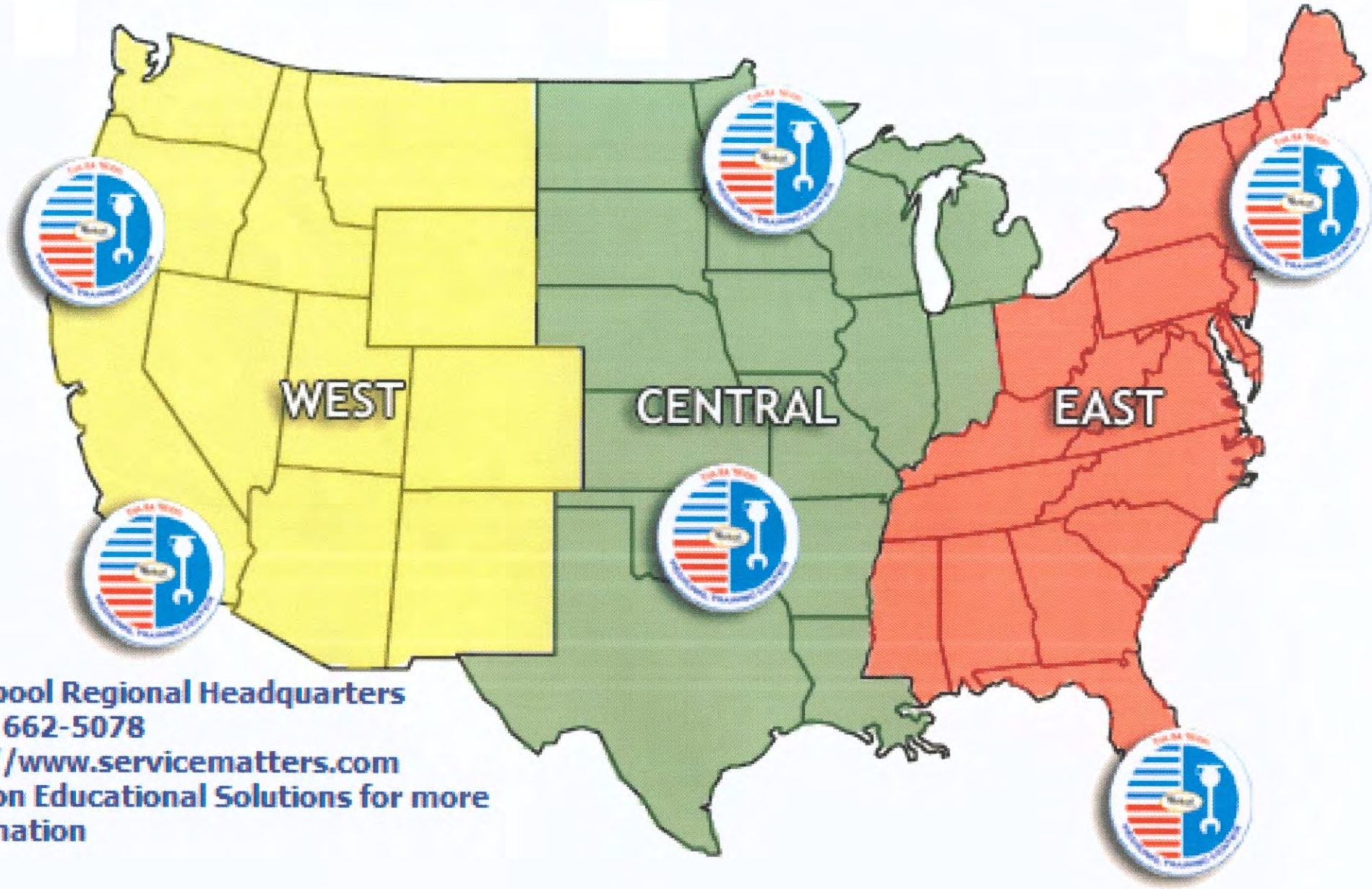
CONSUMER SERVICES TECHNICAL EDUCATION GROUP PRESENTS

G-18

ADJUSTMENT AND REPAIR PROCEDURES TO MINIMIZE CARBON MONOXIDE (CO) LEVELS IN GAS RANGES AND OVENS

JOB AID
Part No. 4322259





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INTRODUCTION

This Job Aid will provide the technician with the information and procedures necessary to properly understand the nature of Carbon Monoxide, test for the possibility of excessive levels and make necessary adjustments and repairs to gas ranges and ovens should excessive levels exist. This Job Aid is supplemental to and does not replace the Product Service Manual or Installation Instructions provided with the individual unit or the Use and Care Guide. In certain instances this Job Aid may refer to these reference manuals for additional information.

GOALS and OBJECTIVES

The overall goal of this Job Aid is to equip the technician with a basic understanding of the existance and dangers of carbon monoxide (CO) and provide procedures for testing for and correcting dangerous levels.

The specific objectives of this Job Aid are to have the technician understand:

- What Carbon Monoxide is and how it is produced.
- How it affects the human body.
- How to test and measure levels of Carbon Monoxide produced by gas ranges and ovens.
- How to adjust and repair gas ranges and ovens to minimize Carbon Monoxide levels.

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TABLE OF CONTENTS

Section One
THE NATURE OF CARBON MONOXIDE (CO)

WHAT IS CARBON MONOXIDE (CO)?

Carbon Monoxide is a chemical compound of Carbon and Oxygen with the chemical symbol CO. CO is an undetectable gas, which means that it has no taste, odor, color and does not irritate the skin or eyes. It has a specific gravity of 0.98, which means it is slightly lighter than air and disperses quickly and freely. Because it is undetectable, and because it is toxic when inhaled, it is often referred to as the "Silent Killer."

Consumer awareness of the dangers of CO in the home has risen drastically over the last few years. In 1993, when CO detectors first went on sale, 400,000 were sold. In the next year, 1994, sales leaped to 3.85 million, and that number is expected to grow by at least four (4) million each year. Over 6 million consumers have CO detectors in their homes today.

CO is a by-product of the incomplete combustion of petrochemicals. This occurs when there isn't enough oxygen to combine with the carbon that is released. Below is a list of items commonly found in the home that may be sources of CO:

- Unvented Gas Cooking Appliances
- Gas, Oil, Wood or Coal Furnace
- Water Heater
- Unvented Gas Clothes Dryer
- Barbecue Grill
- Tobacco Smoke
- Fuel Burning Space Heaters
- Wood Burning Fireplaces
- Blocked Chimney
- Gas Refrigerator
- Automobile Exhaust (Attached Garage)
- Pool or Spa Heaters
- Ceiling Mounted Unit Heater
- Any Other Combustion Based Appliance

CO detectors in the home will alert a consumer that there is CO in the air in concentrations that may be harmful to the inhabitants. A consumer should then call a professional to locate the source of the CO contamination and try to find a solution. This is often done by the local fire department or utility company.

For those who do not have a CO detector in their homes, there are some visual clues that there may be excessive concentrations of CO in the air. These are listed below:

- Loose or disconnected ventilation or chimney connections
- Rust, scale, soot or other deposits on burners, in heat exchange, vent or any appliance clean out
- Debris or soot falling from chimney, fireplace or appliance
- Moisture on insides of windows

None of these visual clues is conclusive, and should not be used as anything more than clues that there may be a CO problem.

All people are in danger of CO poisoning when they are exposed for extended periods of time, or if it is at high enough concentrations. Certain groups of people have lower tolerances than others, and should avoid exposure. Below is a list of these at-risk groups.

- Infants/Children
- Pregnant Women
- People with Angina (Chest Pains)
- Anyone who has trouble breathing
- Elderly People
- Individuals with Anemic Conditions

HOW DOES CO AFFECT THE HUMAN BODY?

Carbon Monoxide can cause a serious health risk because it can only be detected using special instruments. If one does not recognize the symptoms of CO poisoning, or is in a place where the contamination is not very concentrated and therefore not causing these symptoms very quickly, they may not even know they are being effected by CO poisoning. It is important to know these effects so that you can avoid permanent injury or death.

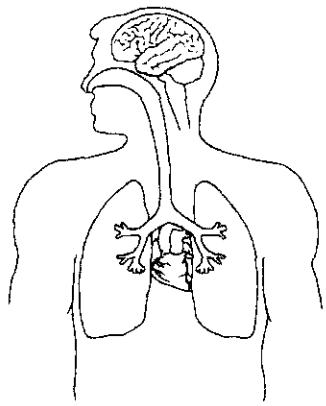


Fig. 1

The particles in the blood that carry oxygen from the lungs to the rest of the body are called Hemoglobin Cells. They attach to the oxygen, which comes into the lungs as a Diatomic Particle (which means there are two atoms stuck together), and flow throughout the body. Once a Hemoglobin Cell has released it's oxygen to be used by the body, it will carry the carbon dioxide (the same chemical released in normal combustion) by-product back to the lungs, where it is exhaled.

When CO is inhaled, it is in the same shape that a diatomic oxygen particle, and is 242 times more attractive to Hemoglobin Cells than oxygen is. It can therefore *REPLACE* oxygen in the blood and reduce the available oxygen level for major body organs.

Even though the blood will carry CO just like normal oxygen, and even though CO does contain one oxygen atom, the bond between the oxygen and the carbon is so strong that the body cannot use it to nourish the cells. It remains attached to the hemoglobin, and does not allow the carbon dioxide the body is producing to be expelled. A person who is breathing too much CO will appear to be suffocating, even though they are able to inhale and exhale freely.

Below is a list of the most noticeable symptoms of CO poisoning:

Mild Exposure:	"Flu-Like" feeling, slight headache, irritability, nausea, vomiting
Medium Exposure:	Disorientation, fatigue, confusion, throbbing headache, drowsiness
Extreme Exposure:	Vomiting, collapse, coma, brain damage, heart and lung failure, death

The Consumer Products Safety Commission (CPSC) states that there are about 300 accidental deaths resulting from CO exposure annually. The American Medical Association puts the number closer to 1,500 accidental deaths per year. The University of Kentucky Medical Center reported that 24% of flu patients are actually suffering from mild exposure to CO, and The Journal of Clinical Toxicology reported that 30% of CO poisonings go unreported. CO is rated as the leading cause of poisoning deaths in the United States.

HOW CAN CONSUMERS BE PROTECTED FROM CO POISONING?

CO Detectors

The most common form of in-home protection available to consumers are Carbon Monoxide Detectors. These detectors will sense the level of CO concentration in the ambient air and emit an audible alarm when those levels are too high. All CO detectors must be UL (Underwriters Laboratories) approved under Underwriters Laboratories 2034 - Design and Performance Standards (revised in 1995).

There are two common types of CO detectors on the market. Most manufacturers (over 30 different manufacturers on market) use the Taguchi/Figaro Electro-Chemical device, a technology that's been around for many years. They usually require a 120 VAC installation.

The second type of CO sensor technology is called Biomimetic Sensing. A Biomimetic sensor mimics the human hemoglobin cells to attract and capture CO particles in ambient air, then tests the amount collected by measuring the electrical resistance caused by the oxidized particles between three electrodes. BRK Brand, Inc. uses Biomimic Sensing in it's First Alert and BRK Electronic brand CO detectors.

CO detectors are available in both 120 VAC or battery powered models. They all must be mounted on a ceiling or high on a wall, but the 120 VAC models must be either plugged into an electrical socket or hard wired. Battery powered models must be accessible, because their batteries must be routinely changed.

The Underwriters Laboratories 2034 Design and Performance Standards (revised in 1995) regarding CO detectors dictates the following alarm levels:

CO LEVEL	ALARM TYPE/TIME STANDARD
400 PPM	Must alarm every 15 minutes
200 PPM	Must alarm every 35 minutes
100 PPM	Must alarm within 90 minutes
15 PPM	Will alarm every 30 days

Below is a listing of the Audible Alarm Types:

Low Battery Alarm: Intermittent chirping signal

Low Level CO Warning: An intermittent warning consisting of a 3 second alarm every 4 minutes (Warns of chronic or CO developing problems within a home)

Full CO Alarm: A continuous alarm signaling that CO is at or is approaching hazardous levels

The revised UL 2034 standard allows for one other feature: The Test/Silence Button. If a warning or full alarm sounds and the consumer presses the Test/Silence Button, the alarm will be silenced for four to six minutes. After this period, the alarm will begin again if the CO level havs not dropped. If CO have returned to a safe level, the alarm will return to normal operation.

The Consumer Product Safety Commission (CPSC) recommends at least one CO detector be installed in every home. They further recommend that it be mounted in or near the sleeping area, and that multilevel homes should have detectors mounted on each level.

CO detectors MUST NOT be mounted directly above an appliance. They should be installed a minimum of 8 to 10 feet from any combustion appliance.

Most CO detectors will have a test button that can be pressed to verify proper operation. Most manufacturers recommend that the test button be pressed to test the unit weekly. Battery powered units will require battery replacements every two years at the longest, and all units require sensor pack replacements every two years. Some manufacturers will offer extra features such as extended-life sensor packs or indicator lights to ensure proper operation.

CARBON MONOXIDE EMISSION STANDARDS

Ambient Level CO Exposure Standards

There are many ways that Carbon Monoxide measurements can be stated. One of the most common forms is the Diluted or Atmospheric reading which is reported as a single gas, and is stated in parts per million (PPM). Most ambient levels are measured in this way. CO can also be measured in percentage (Percent by volume), but this is uncommon.

CO Air-Free (CO A/F) is a calculation that allows a carbon monoxide reading to be stated as an Undiluted or Absolute reading in PPM. For this reason, this is the method used most commonly to measure appliance and heating equipment emissions.

The CO A/F measurement is computed from the CO and O_2 measurements. It is a concept for determining the amount of CO present in a sample of air by compensating for the amount of excess air provided by the burner. Excess air from a burner dilutes the products of combustion, causing a CO test to be *understated*. A CO A/F measurement eliminates the excess air dilution.

Instruments can now determine the CO A/F reading by measuring both the CO and O_2 levels, then calculating the formula below.

$$\frac{20.9}{20.9 - O_2} \times \text{Measured CO (In PPM)} = \text{CO Air Free}$$

Standards Overview

Various authorities have set human CO exposure standards:

CPSC (Consumer Product Safety Council): Maximum exposure level of an average of 15 PPM over 8 hours; maximum average of 25 PPM over 1 hour.

EPA (Environmental Protection Agency): Maximum level of 9 PPM over 24 hours as the residential interior ambient level maximums standard (**Note:** A properly ventilated home will have a normal CO level less than 5 PPM).

OSHA (Occupational Safety and Health Association): Maximum of 50 PPM over 8 hours in a work environment.

The AGA (American Gas Association) publishes CO emissions standards for appliances and heating equipment through ANSI (American National Standards Institute) as ANSI Z21.1. These maximums are stated in CO A/F and do not necessarily relate to human exposure standards. Three standards are applicable:

800 PPM - Maximum concentration allowed from an unvented gas oven

400 PPM - Maximum concentration allowed from furnace flue gas

200 PPM - Maximum concentration allowed from an unvented space heater

The reason for the different emission standards presented above results from considerations stemming from the type of appliance, its usage and its potential for extended operating time.

Non-vented gas cooking appliances in a residential application are normally used for short periods of time (a few hours or less). The CO generated during operation will disperse to the air in the house and be purged to the outside through normal air exchange.

Vented appliances such as furnaces and hot water heaters are limited to 400 PPM as they are expected to operate at full output for extended periods. Normal operation can vary from a few hours to days at a time. All vented appliances are required, by law, to be connected to a properly operating venting system. Correctly installed, all products of combustion are discharged directly to the outside of the house. Vented appliances are safe during normal operation, but can become hazardous if the venting system fails to remove the products of combustion.

Non-vented space heaters, however, are restriced to a much lower CO emission level because of their potential for extended operating time and/or misuse. All manufacturers of these products publish warnings to the users to provide additional ventilation in the area of use during operation (open a nearby window about 1".) Used properly, the CO emissions will disperse to the air in the house and be purged to the outside through normal air exchange.

-- NOTES --

Section Two

HOW CARBON MONOXIDE IS PRODUCED

BURNER OPERATION

The unit used to measure the amount of heat a gas burner produce is called the British Thermal Unit (BTU). All gas burners and fuel gasses have BTU ratings. This can be compared to the wattage of an electrical heating element. Most surface burners used on current gas ranges have been rated between 9,000 to 12,000 BTUs. The BTU rating is listed on the model and serial label attached to the range. *(Fig. 2)*

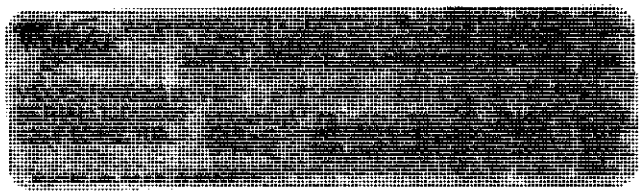


Fig. 2

In order to understand how a burner operates in more detail, it is important to first have an understanding of the following terms *(Fig. 3)*:

Gas: This is the fuel used by the burner, either natural or L.P.

Primary Air: This is the air mixed with the gas in order to make the gas combustible.

Secondary Air: This is supplemental air or ambient air surrounding the flame.

Air/Gas Ratio: Comparison of amounts of fuel gas and air to act as primary and secondary air.

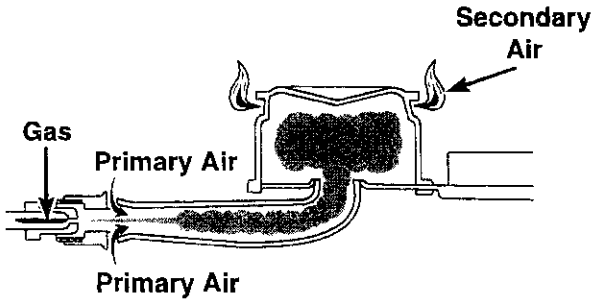


Fig. 3

For proper operation, a burner needs the correct amount of gas mixed with the correct amount of air. This is called a correct air/gas ratio. A correct air/gas ratio will result in a flame that is stable without yellow tips. The ratio depends upon the fuel gas type being used. Ten cubic feet of air are needed to completely burn one cubic foot of natural gas (10 to 1 ratio, 10:1) and twenty-four cubic feet of air are needed to completely burn one cubic foot of L.P. gas (24 to 1 ratio, 24:1). *(Fig. 4)*

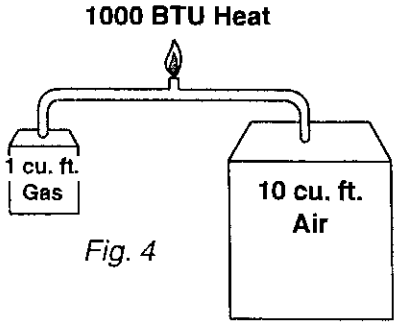


Fig. 4

When broken down into primary and secondary air, 70% to 80% of the total air required is mixed with the gas as primary air. The remaining 20% to 30% is pulled into the flame as secondary air.

Mixing Gas and Primary Air

Gas entering the burner first flows through a gas metering orifice. *(Fig. 5)* The diameter of the hole on this orifice regulates the amount of gas that enters the burner. The size of this hole is calculated based upon the BTU rating of the gas, the regulated delivery of the gas, and the BTU rating of the burner.

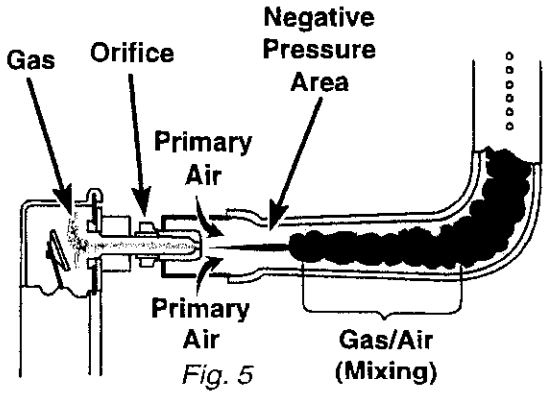


Fig. 5

As the pressurized gas stream flows out of the orifice and into the base of the burner, a vacuum is created around the gas flow. This vacuum is called Aspiration. Primary air is pulled in by aspiration and mixes with the gas in the mixing zone.

The amount of primary air pulled in is determined by the size of the air shutter opening (on burners with air shutters) or by the distance between the orifice and the base of the burner (on burners without air shutters).

The gas must be injected straight into the burner in order to pull the right amount of primary air into the mixing zone. If the gas is injected at an angle, the strength of the aspiration will be reduced. This loss of vacuum will result in too little primary air being mixed with the gas. Yellow tipping of the burner flames will appear. The same problem will occur if the orifice is partially blocked with debris from a spill, a burr in the orifice opening, or a distorted orifice pin (due to over tightening the orifice hood during the adjustment to operate on L.P. gas).

When the air and gas are properly adjusted, the flame will burn cleanly and steadily without yellow tips and will have the proper BTU output.

For a properly burning flame, *(Fig. 6)* the air/gas mixture must be supplied to the burner at the same rate as the burning speed. The speed at which the air/gas mixture burns can be altered by varying the amount of primary air in the air/gas mixture.

Increasing the primary air will result in an increased burning speed. If the increase is too large the flame will blow off of the burner.

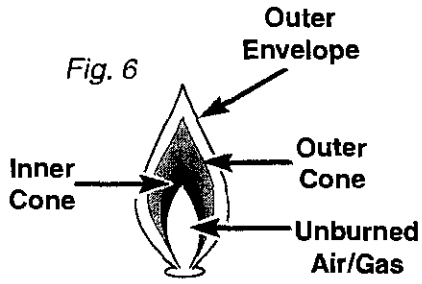


Fig. 6

Reducing the primary air will slow the burning speed. Too little primary air will result in yellow tips forming on the end of the burner flame.

Starvation of primary air will create a flame without the normal definition or cone structure that is seen on properly burning flames. This flame will burn off of the burner and will occasionally leap upward. A lazy flame without structure is a sure sign of incomplete combustion.

Combustion

A Gas Range is not vented to the outside of a house like gas water heaters and gas furnaces. All by-products of combustion from a gas range are released directly into the room. When combustion occurs, the by-products can include Carbon Monoxide or possibly Aldehydes. Obvious signs of incomplete combustion are yellow flames, soot, and strong chemical odor from the aldehydes.

Incomplete combustion can usually be traced to one of three common causes:

Quenching of the Flame: Flame Quenching occurs when the flame is cooled before complete combustion can occur. As an example, a surface burner could have been bent upward to the point that the flame contacts the bottom of the pot. The cooling effect of the pot interrupts the combustion process before complete combustion can take place. *(Fig. 7)*

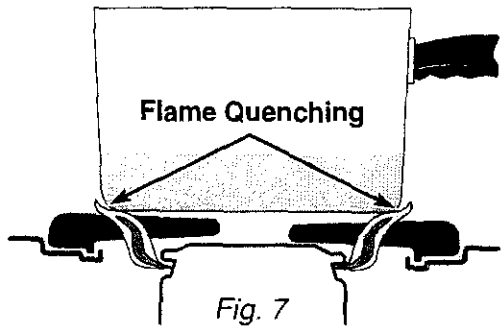


Fig. 7

Improper Gas/Air Ratio: This is the most common cause of incomplete combustion.

Over fueling the Burner: This occurs when the volume of gas supplied to the burner is too large. This will result in an "over fueled" burner. The flame size will exceed the BTU rating of the burner.

Properly Burning Flame

A properly burning flame has an inner cone, an outer cone and an outer envelope. These three parts should be definable and distinguishable, although the outer envelope may not be easy to see. *(Fig. 8)*

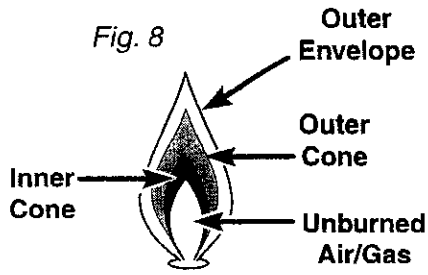


Fig. 8

The inner cone is the point where the air/gas mixture ignites and the combustion process begins. High levels of Carbon Monoxide and Aldehydes are produced in this cone.

The outer cone surrounds the inner cone. The outer cone is the hottest part of the flame. Secondary air is drawn into the flame at this point and accelerates combustion. As the by-products from the inner cone move into the outer cone, they are burned and transformed into harmless Water Vapor (H_2O) and Carbon Dioxide (CO_2). If there is not enough secondary air (or it is poorly ventilated and stagnant) this process cannot occur completely, and some of the harmful by-products from the inner cone will skip into the outer envelop.

The outer envelope surrounds the outer cone. The combustion process has been completed by the time the chemicals reach this point. The glow of the envelop is the result of the hot Carbon Dioxide and Water Vapor exiting the outer cone.

Too Much Primary Air

As the primary air is increased, the gas/air mixture burns at a faster speed (like fanning a flame). The additional primary air results in a greater volume of air/gas flow through the burner ports.

With increased delivery pressure and a faster burning flame, the result is a flame that blows straight out of the burner and burns with a sound similar to a blow torch. The flames lift off the burners and the cone structure of the flame is disrupted. *(Fig. 9)*

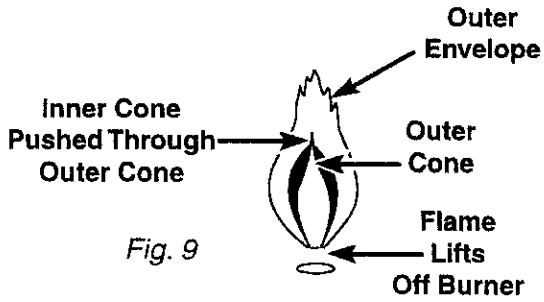


Fig. 9

The inner-cone combustion process will occur in increased levels, and will release more of the harmful by-products, CO and Aldehydes. The level of secondary air will no longer be enough to convert these chemicals into the safe by-products CO_2 and H_2O, and there will be higher levels of dangerous chemicals released into the room.

NOTE: It is normal for the burners without mixing tubes to have blowing flames during the first minute of operation. When the burner is cold, primary air injection is increased. Once the burner heats, the injection of primary air is reduced and the flames settle.

Too Little Primary Air

The reduction of primary air slows the burning process and results in the inner cone rising higher in the flame. Less burning takes place in the inner cone. A larger amount of the by-products that would be consumed in the inner cone pass into the outer cone.

The size of the outer cone is also reduced by the lack of primary air. The outer cone cannot consume the volume of by-products flowing from the inner cone. A percentage of these by-products flow into the outer envelope where the carbon content of the by-product is burned. This shows up as yellow tips. *(Fig. 10)*

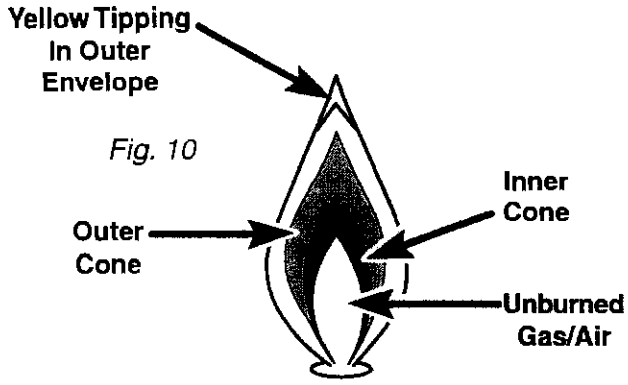


Fig. 10

Over Fueled Burner

Over fueling of the burner can be caused by one of three common causes:

- Excessive gas pressure entering the burner
- The BTU rating of the gas can be too high for the burner
- An oversized gas metering orifice

It is difficult to recognize the difference between an over fueled burner and too much primary air. In both cases, the burner flame length extends too far off of the burner. *(Fig. 11)*

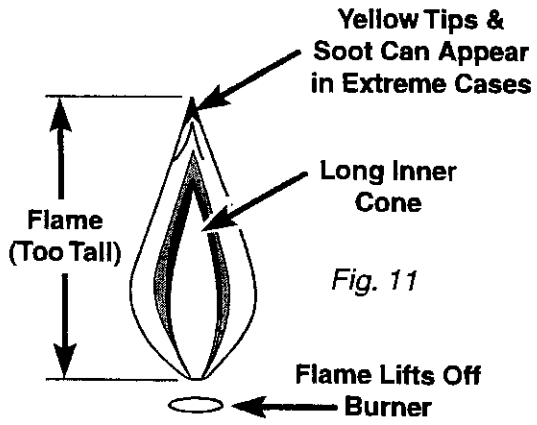


Fig. 11

The over fueled burner has more of a normal flame structure and less of a blowing noise than a burner with too much primary air. The easiest way to determine whether the burner is over fueled is to vary the air shutter opening size. If the flame length can be reduced to the correct size and structure by adjusting the air shutter, then the problem is not an over fueled burner.

If the air shutter adjustment will not correct the problem, turn the orifice hood in the L.P. direction while observing the change in flame length and structure. Top burners should have a cone length of approximately ¾". *(Fig. 12)* Oven burners should have a cone length of approximately ½" with the flame spreader removed. *(Fig. 13)*

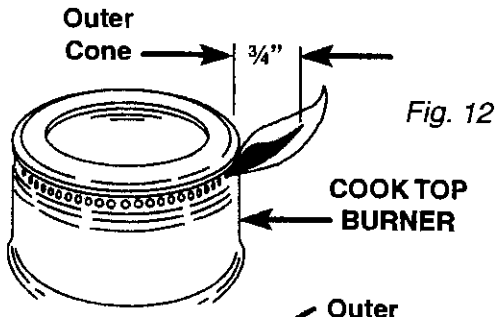


Fig. 12

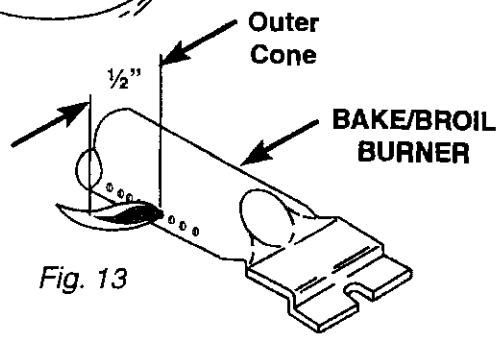


Fig. 13

For L.P. installations and models without adjustable orifices, the orifice must be replaced with an orifice one size smaller.

Flame Quenching

As discussed earlier, flame quenching occurs when the flame is cooled before complete combustion occurs.

Placing and object such as an oven flame spreader into the flame will cool or quench the flame, resulting in an incomplete combustion. The object interrupts the combustion process and releases the unburned by-products from the inner or outer cone of the flame.

The height of the surface burners in relation to the burner grates should always be closely examined and measured. If the burner is too close to the grate or too close to the main top, quenching can result and possibly cause damage to the main top.

Top burners can be bent out of adjustment easily by putting excessive weight on them, for example, by leaning on them. The distance from the highest point of the burner to the top of the grate should be approximately ¾". *(Fig. 14)*

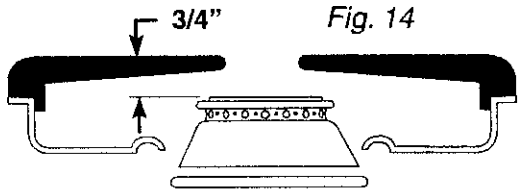


Fig. 14

In the case of an over fueled burner, the excessive length of the flames can result in the quenching at the oven flame spreader or top burner grate even through the flame spreader and grate may be at the proper distance. Check for this before adjusting the burners.

When quenching occurs, *(Fig. 15)* the customer may complain of a chemical odor. This odor results from the Aldehydes being released from the flame as one of the by-products of incomplete combustion. Some customers may associate this odor with a gas smell, but the two odors are quite different. By examining the flame length between the burners and other components and by looking for an out of place component the cause of the quenching can easily be located.

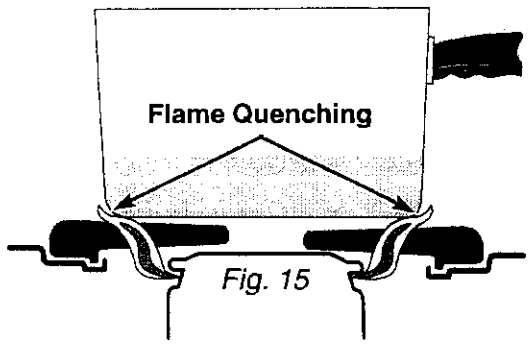
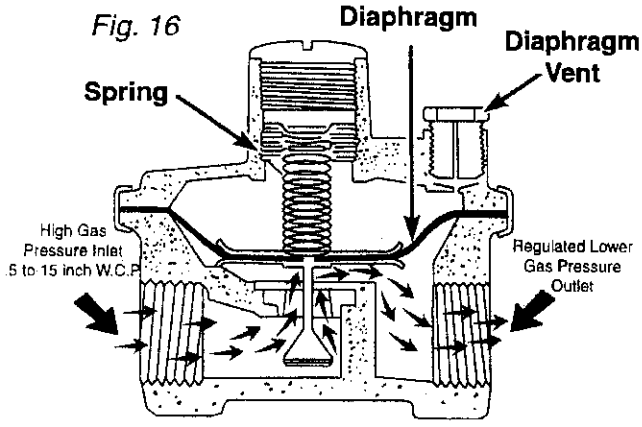


Fig. 15

Gas Pressure and Pressure Regulators

The pressure of the gas coming into the pressure regulator pushes against a spring-loaded diaphragm forcing it upward. The diaphragm spring puts pressure on the gas. The diaphragm has a tapered plug suspended from it to restrict or increase the gas flow pressure. *(Fig. 16)*

Fig. 16



As the gas pressure against the diagram drops, the tension from the spring pushes the diaphragm downward, moving the tapered plug down away from the passage way and allowing more gas pressure to flow into the burners. Additional gas may then flow into the regulator, pushing the diaphragm back up, thus restricting the flow of gas pressure into the passage way, and the cycle can repeat. In this way, the diaphragm and tapered plug maintain a constant gas pressure level to the burners.

The amount of spring tension applied to the diaphragm determines the output pressure of the regulator. To increase the amount of gas pressure output, use a reversible plunger or reversible spring access cap to add more tension to the spring.

As a safety feature, the regulator will "lock-up" and restrict all gas flow during any situation that applies extreme pressure to the incoming gas supply line. The regulator can be unlocked by removing the spring access cap and pushing down on the diaphragm with the eraser end of a pencil.

Measuring Gas Pressure

Gas pressure for home use is measured in inches of Water Column Pressure (WCP). It takes 28 inches of water column pressure to equal 1 Pound per Square Inch (PSI).

In most locations, natural gas entering the home is regulated between 6 and 7 inches WCP. L.P. gas is regulated to 11 to 13 inches WPC. The appliance pressure regulator reduces the incoming pressure to the required amount which is usually about 4 inches WCP for natural gas installations (though there are some models that require as much as 6 inches WCP natural gas) and 10 to 10½ inches WCP for L.P. installations.

NOTE: There are areas, especially in older sections of most major cities, where the gas supply pressure will drop as low as 2 or 3 inches WCP. If a technician is called in to repair a unit that does not appear to be getting enough gas and finds this to be the reason, there is nothing he can do but show the customer what the readings are and explain the requirements for the appliance. The customer should be referred to the local gas company.

A manometer is used to measure gas pressure in inches of water column pressure. *(Fig. 17)* A manometer is a clear tube shaped like the letter "U". Markings on the legs of the tubing divide the tubing into increments of inches. Usually the mid point of each leg is the zero inches WCP point and the one inch increments extend above and below this point.

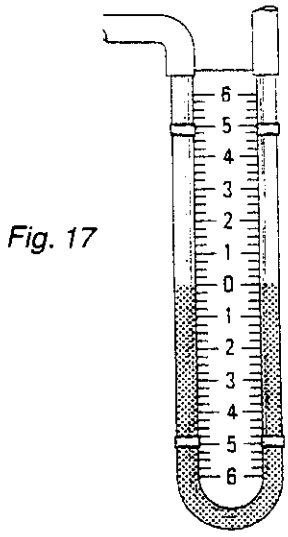


Fig. 17

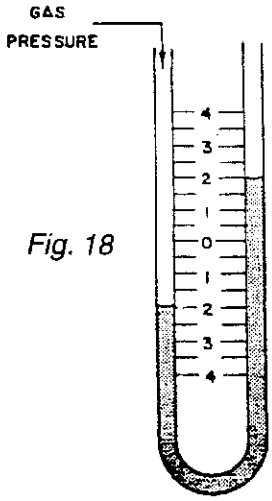


Fig. 18

To use the manometer, pour enough water into the tube to bring the water level of both legs to the zero point. Using a little food coloring in the water will make reading the gauge easier.

Connect the tubing (Supplied with the manometer) over one end of the manometer. Remove a burner from the appliance and place the other end of the tubing over the burner orifice. Turn on the gas to the orifice being tested and light at least one other burner to serve as a load.

Observe the movement of the water in the manometer. The gas pressure is read by adding the inches of water movement in both legs of the gauge. *(Fig. 18)*

Example: If the manometer shows a water level of 2" below the zero point on the left leg and 2" above the zero point on the right leg, add the movement of the water in both legs together; the manometer reads 4" WCP.

The magnehelic gauge is simpler and faster to use. *(Fig. 19)* To make a pressure reading:

- Connect the gauge to the pressure tap with rubber tubing
- Turn on the gas

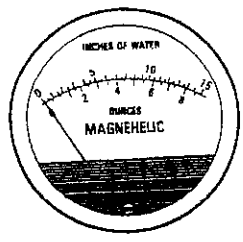


Fig. 19

- Make a direct reading of the pressure from the scale. Some gauges have both the "Inches Water Column (WCP)" scale and the "ounces per square inch" scale on the dial face. Use the "Inches Water Column (WCP)" scale.

Appliance Regulator Test

Before measuring the gas pressure, examine the appliance rating plate and find the pressure required.

Connect a manometer to one of the burner orifices and turn another burner on. The gas pressure must not fall below ½ inch of the required operating pressure regardless of the number of burners in use. If the gas pressure is too low with only one burner in operation or with no burners in operation, test the supply pressure.

-- NOTES --

Section Three
USING THE BACHARACH MODEL PCA-12 COMBUSTION ANALYZER

TESTING FOR CARBON MONOXIDE IN THE HOME

1. Determine the type of fuel being used, natural or L.P.
2. Follow the instructions provided with the test equipment to prepare the instrument for use. (The Bacharach PCA-12 will take 60 seconds to warm-up).
3. Program the oven to Bake at 500°. Setting the control (thermostat) to a high setting insures that the oven burners do not cycle during testing.
4. Let the oven operate for **7 minutes** before measurement is attempted. Do not have the test equipment on or around the oven vent during the oven warm-up period.
5. After the **7 minute** oven warm-up period, insert the probe supplied with the tester into the oven vent. The probe should be inserted to the left or right side of the vent. There may be a diverter in the middle of the vent that could provide incorrect measurements.
6. Press the **RUN** keypad.
7. Wait for the *CO Air Free* reading to stabilize.
8. Press the **RUN** keypad again to lock in the test results.
9. Record your test results on the work order.

Measurements must be within ANSI (American National Standards Institute) standards:

800 PPM CO Air-Free

If test results of Carbon Monoxide Air-Free are above 400 PPM, minor adjustments to the appliance should be performed accordingly.

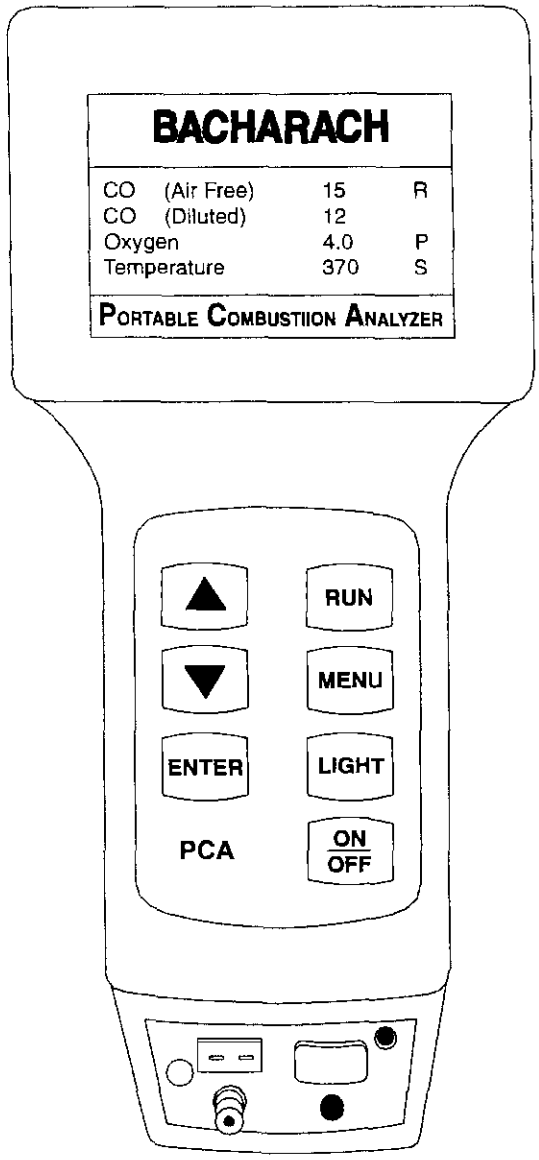


Fig. 20

Cooktop Measurements

This measurement can not be done in the field. Top burners should be visibly checked for proper burner flame: No yellow tipping, no "blow torch" flame, correct pilot light when applicable, etc. See Section Four, **Adjustments and Repair Procedures**.

-- NOTES --

Section Four
ADJUSTMENT AND REPAIR PROCEDURES
INTRODUCTION

Once you have determined that a gas range is not operating within standards, you can proceed with the repair of the unit. There are two possible causes of the problem, and it is simple to decide which one it is.

The first cause you should check for is that the Cooktop Burner Venturi or Orifice may be damaged (plugged or deformed), and causing improper combustion or improper adjustment of the burner flame. Carefully inspect the burner and decide if it is, in fact, damaged. If so, the burner must be replaced.

The second cause you should check for is that the ratio of free air to fuel may be bad. Checking for this problem involves a number of steps, and is done along with some adjustments, all of which are listed in this section.

BURNER ADJUSTMENT

Bake Burner Adjustment

Burner adjustment is accomplished by either adjusting the air shutter or the orifice. Follow the directions below to determine what the correct course of action is in your specific situation.

1. Remove the oven bottom, flame spreader and orifice shield. (Some flame spreaders are not removable.)
2. Set the oven to BAKE.
3. Observe the burner flame for both flame length and quality. The flame should be approximately ¾" to 1" in total length with an inner cone approximately ½" long. There should be no yellow tips on natural gas units, and very little to no yellow tips on L.P. gas units.

Harshly Blowing Flames indicate that there is too much primary air being mixed with the gas. Reduce the air shutter opening until the flames settle.

Yellow Tipping or fluttering flames indicate that there is too little primary air mixing with the gas. Open the air shutter until the flames take on the proper characteristics. If opening the air shutter does not solve the problem, reduce the gas flow to the burner by adjusting the orifice (see below).

Excessively long flames should be adjusted so they do not extend beyond the edge of the flame spreader.

With the flame spreader removed, it is easy to determine the overall flame length. Examine the heat pattern on the burner side of the flame spreader. If it extends all the way to the edge of the spreader, the flame is too long.

To correct an excessively long burner flame, set the oven for BAKE with the spreader removed. Turn the orifice hood in the L.P. direction while observing the flame. Stop turning once the flame length is ¾" to 1" long. Shut off the oven, wait for it too cool and reinstall the flame spreader. Now turn the unit back on to BAKE and be sure the flame does not extend beyond the edge of the flame spreader.

Broil Burner

To determine the status of a Broil Burner, follow the directions below before attempting any repairs.

- Set the oven to BROIL.
- Observe the burner flame for flame length and quality. The flame should extend just short of the edge of the flame spreader, and should have no yellow tipping . Some L.P. units will be burning a fuel that will cause yellow tipping).

A harshly blowing flame indicates that there is too much primary air being mixed with the gas. Reduce the air shutter opening until the flames settle.

Yellow Tipping or fluttering flames indicate that there is too little primary air mixing with the gas. Open the air shutter until the flames take on the proper characteristics. If opening the air shutter does not solve the problem, reduce the gas flow to the burner by adjusting the orifice.

Excessively long flames must not extend beyond the edge of the flame spreader. If the flame is too long, set the oven to BROIL, and turn the orifice hood in the L.P. direction while observing the flame. Continue turning the orifice hood until the flame no longer extends beyond the flame spreader.

Conventional Surface Burners

NOTE: Before making any adjustments to any burners, check the height of the burner in relation to the grate. The dimensions from the highest point on the burner to the top of the grate must be ¾". The burner can be formed (bent) to the proper dimension.

Turn the burners to HIGH and observe the flames. The inner blue portion of the flame should be approximately ¾" in length and L.P. units should have no yellow tips. Some L.P. units can burn a fuel that will cause yellow tipping.

Harsh blowing flames indicate there is too much primary air being mixed with the fuel. Turn the air shutter towards the closed position until the flame settles.

With the air shutter adjusted for the best possible flame, examine the length of the flame. If the inner cone of the flame is in excess of ¾" or if the flames have yellow tips, turn the orifice hood in the L.P. direction while watching the flame. This will reduce the gas flow to the burner and should reduce both the flame length and the yellow tips. It may be necessary to adjust the air shutter after adjusting the orifice hood.

Soft yellow flames indicate that there is too little primary air being mixed with the gas. Open the air shutter until the yellow tipping of the flames disappears. With the air shutter adjusted for the best quality flame possible, examine the length of the flame. If the flame seems too small, check for the following:

Natural Gas Installations:

- Are the Natural Gas orifices correctly installed?
- Is there at least 4" WCP of gas pressure available to the burners when all four burners are operating?

L.P. gas Installations:

- Was the regulator converted for L.P. use?
- Is there at least 10" WCP of gas pressure available to the burners when all four burners are operating?
- Are the L.P. orifice hoods installed?

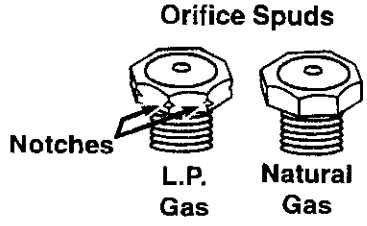


Fig. 21

Low Flame Adjustment (Not available on all models.)

Turn the burners to SIMMER and observe the flame's characteristics. If the flame is unsteady or goes out completely, the flame is called a Low Flame. Follow the following procedure to correct it.

1. Ignite all of the burners, then turn the burner to be adjusted to the SIMMER setting
2. Remove the control knob for the burner to be adjusted and locate the low flame adjustment screw inside the valve stem.
3. Hold the valve stem steady and turn the LOW flame adjustment screw until the flame achieves the desired SIMMER flame characteristics.
4. When the burner is properly adjusted, put the knob back on the valve stem.

Switch the burner from the highest to the lowest settings several times. If the burner flame goes out, the flame setting is too low and needs to be readjusted.

Open and close the oven door several times after adjusting the low flame while the burner is set on SIMMER. If the flame is extinguished, the flame is set too low and needs to be readjusted and tested again.

Sealed Burners

Sealed burners are designed to operate with less secondary air surrounding the burner than conventional burners. The reduced secondary air requirement eliminates the need for the large opening surrounding the burner that is present on conventional surface burners. The primary air mixes with the gas in the venturi tube similar to conventional burners.

The burner is a two piece system consisting of a burner base and a removable burner cap. The gas metering orifice is nonadjustable, and there are no air shutters. Each burner has its own individual spark electrode, and some ignition systems have a flame sensing auto relight system.

Standard adjustments to the air shutters and gas metering orifices are not possible on these burners. If the burner flames appear to be abnormal, check the following:

1. Check the gas pressure to the burners. The required operating pressures are:
   - Natural gas: Four (4) to six (6) inches WCP (See the serial tag)
   - L.P. gas: Ten (10) inches WCP.
2. Check for drafts entering the burner box from behind the range. Strong drafts may extinguish the burner and/or cause an abnormal flame.
3. Check for partial or total blockage of the orifice opening.
4. Check to make sure the range is set for the type of gas in use. If it has been adjusted to L.P., make sure the adjustments were done correctly.
5. Check to see if the abnormal flames occur only when the oven is in operation, be sure the range was installed correctly. Examine the oven burners to verify proper operation and adjust as necessary.

Low Flame Adjustment (Not available on all models.)

NOTE: To adjust the SIMMER flame setting on sealed burners, at least two other burners must be operating on a MEDIUM to HIGH setting. This will prevent the low setting from being set too low, which will cause the flame to go out when more than one burner is in operation.

The low flame adjustment screw may be located on the valve body or under the knob in the shaft of the valve. The spark switch may make it hard to see.

1. Ignite the burner, then turn the burner to the SIMMER setting.
2. Remove the control knob for the burner to be adjusted and locate the adjustment screw.
3. Hold the valve stem steady and turn the LOW flame adjustment screw until the flame achieves the desired SIMMER flame characteristics.
4. When the burner is properly adjusted, put the knob back on the valve stem.

Switch the burner from the highest to the lowest settings several times. If the burner flame goes out, the flame setting is too low and needs to be readjusted.

Open and close the oven door several times after adjusting the low flame while the burner is set on SIMMER. If the unit you are working on is a countertop model, open and close the cabinet door underneath the range. If the flame is extinguished, the flame is set too low and needs to be readjusted and tested again.

L.P. GAS CONVERSION

1. Check that the main gas supply line has been shut off and the power supply cord is disconnected.
2. Remove burner grates, caps and screws holding burner bases to the cooktop. Lift burners off cooktop. *(Fig. 22)*
3. Remove storage drawer and oven racks. The pressure regulator is located at the rear of the cabinet behind the storage drawer. *(Fig. 23)*
4. Pressure Regulator *(Fig. 24)*: Turn cap marked "N" on front of pressure regulator counterclockwise with a wrench to remove. Do not disturb or remove the spring beneath the cap. *(Fig. 25)* Install cap on the regulator so that the letters "L.P." are visible. Close plastic cover over cap.
5. Cooktop Burners: Pull range out from countertop front about 4 inches. Remove the cooktop.
6. Prop open cooktop. Remove the venturi plate. Locate L. P. gas orifice spuds in a literature package included with the range. Orifice spuds are color coded. *(Fig. 26)* Remove one Natural gas orifice spud at a time using a 3/8 inch combination wrench. Install the same color L. P. gas orifice spud *(Fig. 27)* to replace the Natural gas orifice spud.

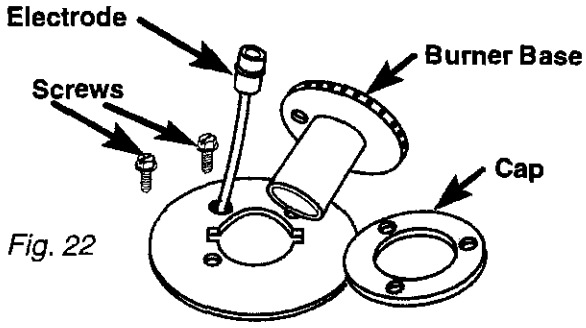


Fig. 22

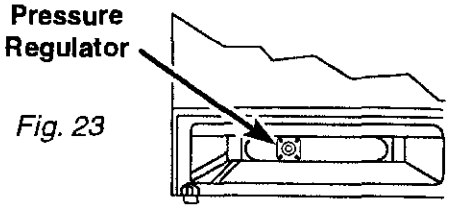


Fig. 23

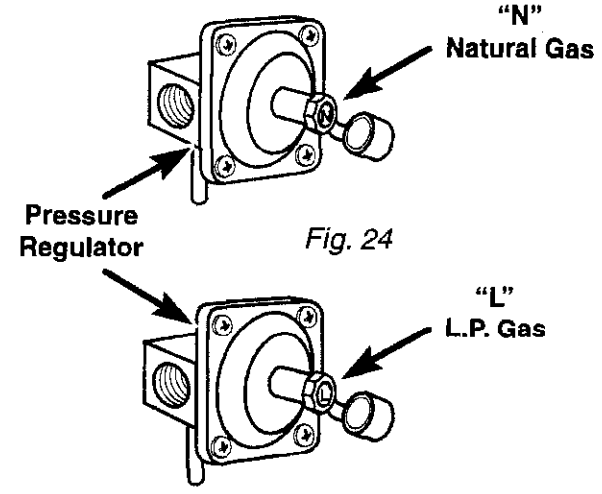


Fig. 24

Place Natural gas orifice spuds in a plastic parts bag and keep it with the literature package. Reinstall the venturi plates. Lower cooktop to operating position. Reinstall burner bases, screws, caps and burner grates.

7. Oven Burner *(Fig. 28)*: Use a ½ inch combination wrench to turn the orifice hood down snug onto pin (approximately 2 to 2-½ turns). DO NOT OVERTIGHTEN the orifice hood. The burner flame cannot be properly adjusted if this conversion is not made.

8. Broil Burner *(Fig. 29)*: Use a ½ inch open-end wrench to turn the orifice hood down snug onto pin (approximately 2 to 2-½ turns). DO NOT OVERTIGHTEN the orifice hood. The burner flame cannot be properly adjusted of this conversion is not made.

9. Reinstall the storage drawer. Check for proper flame. The small inner cone should have a very distinct blue flame ¼" to ½" long. The outer cone should not be as distinct as the inner cone. L. P. gas flames have a slightly yellow tip. If the flame is noisy or blowing, it is getting to much air. If the flame is soft and lazy, it is not getting enough air.

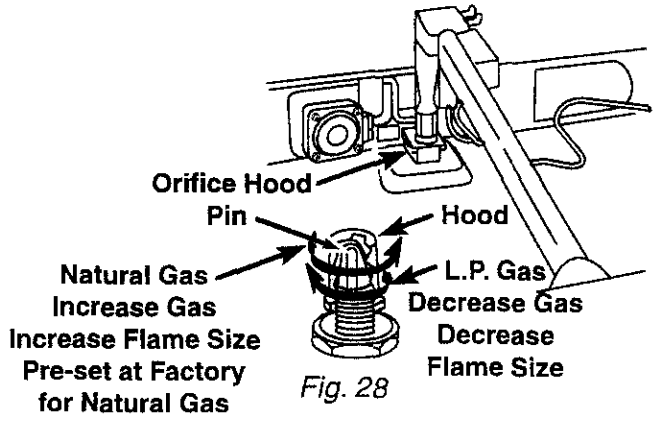


Fig. 28

NOTE: These are L. P. conversion procedures for the "E" line freestanding ranges - refer to the L. P. conversion instructions for the unit you are servicing.

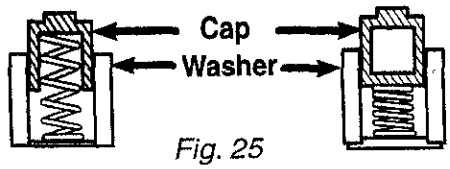


Fig. 25

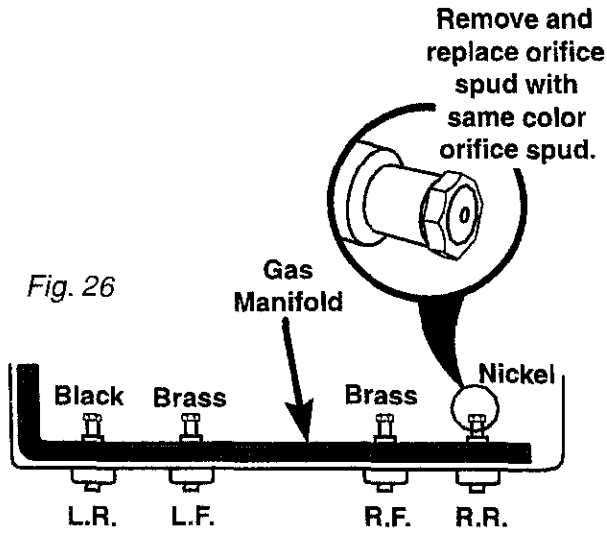


Fig. 26

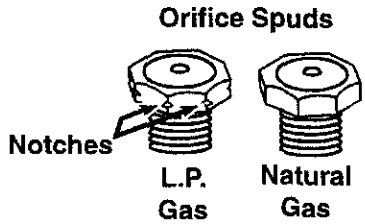


Fig. 27

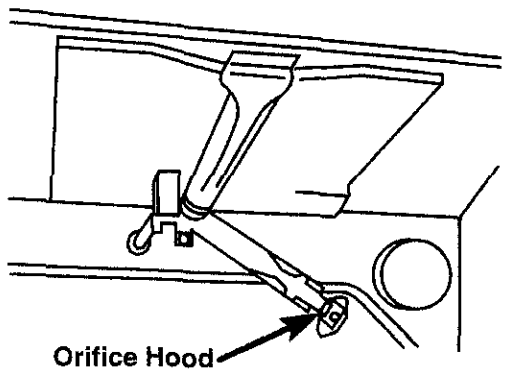


Fig. 29

Section Five
REPORTING

CUSTOMER RELATIONS ISSUES

Consumer Concern Response

When a consumer calls with a carbon monoxide safety concern, you must immediately contact the Consumer Assistance Center (CAC) Safety Team (1-800-541-5746) so they can initiate an investigation. A service call to check and address any carbon monoxide concerns must be provided within 24 hours.

All safety related inspections will be provided free of charge to the consumer. **Process all safety related claims as a "SPECIAL AUTHORIZATION." List project #S33553** in the special authorization space of the NARDA Form and process it as any other warranty claim. Document CO A/F readings on the NARDA Form and obtain a customer signature.

All carbon monoxide inspection calls must be processed according to the "Testing For Carbon Monoxide in the Home" process in Section Three (page 15) of this Job Aid.

RED TAGGED UNITS

When a unit has been "Red Tagged" by a Utility Company because of anticipated unsafe Carbon Monoxide (CO A/F) levels, the technician should inspect and/or repair the unit as described above, then instruct the customer to call the Utility Company with the test results of the service call and have the unit placed back into service.

If, after testing procedures are performed, the CO A/F level cannot be safely regulated as described in Section Four, "Adjusting and Repair Procedures," (page 17) of this Job Aid, immediately contact the CAC Safety Team (1-800-541-5746) so they can process the claim. Document CO A/F readings on the NARDA Form and FAX a copy of the NARDA Form to the CAC (1-616-923-7038)

Explaining Inspection Results to the Consumer

The difference in measurement systems can cause a very confusing situation for the consumer. The fact is that it may be necessary to tell them that a problem is worse than they thought, or that it isn't much of a problem at all.

Many consumers who become aware of elevated CO levels in their homes will call a professional to inspect the situation, and try to find the source. They will be most likely looking for infractions to the EPA ambient air CO level guidelines (see page 4 of this Job Aid). These professionals, who are often Firemen or representatives of the local utility company, may be monitoring the "Diluted CO" measurement (CO) rather than the CO A/F (undiluted)measurement which is more accurate.

When you are called to inspect a Gas Range, it is important to make your own readings and be sure to find the CO A/F readings as the original readings may have been taken in CO only. CO only readings are not recognized by the American National Standards Institute (ANSI).

When explaining this situation to the customer, it is important to give them a basic understanding of the two measurement systems, (diluted vs. undiluted, page 4) and to explain to them the reasons that they are both used.

If a home has a high level of CO in its ambient air, it could be caused by many factors. Any gas burning appliance might emit some level of Carbon Monoxide; cigarette smoke, car exhaust and wood burning

fireplaces can all be causes, too. If a number of CO sources are all present in an area with poor ventilation, it could cause high levels of CO without breaking any standards for emissions from any one appliance. It is possible that a range is a factor in a problem, but it is not the only factor, if it is acting within acceptable CO emissions levels.

If a unit is tested by a technician, and found to be operating above the ANSI standard of 800 PPM CO A/F, then the unit is to be repaired. If it is tested by a technician and found to be operating at safe levels (below 800 PPM CO A/F), then it must be explained to the customer that the level of CO in the ambient air might be high, but it is not because of a malfunctioning Gas Range. It could be from a combination of low-level CO sources, or from poor ventilation.

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