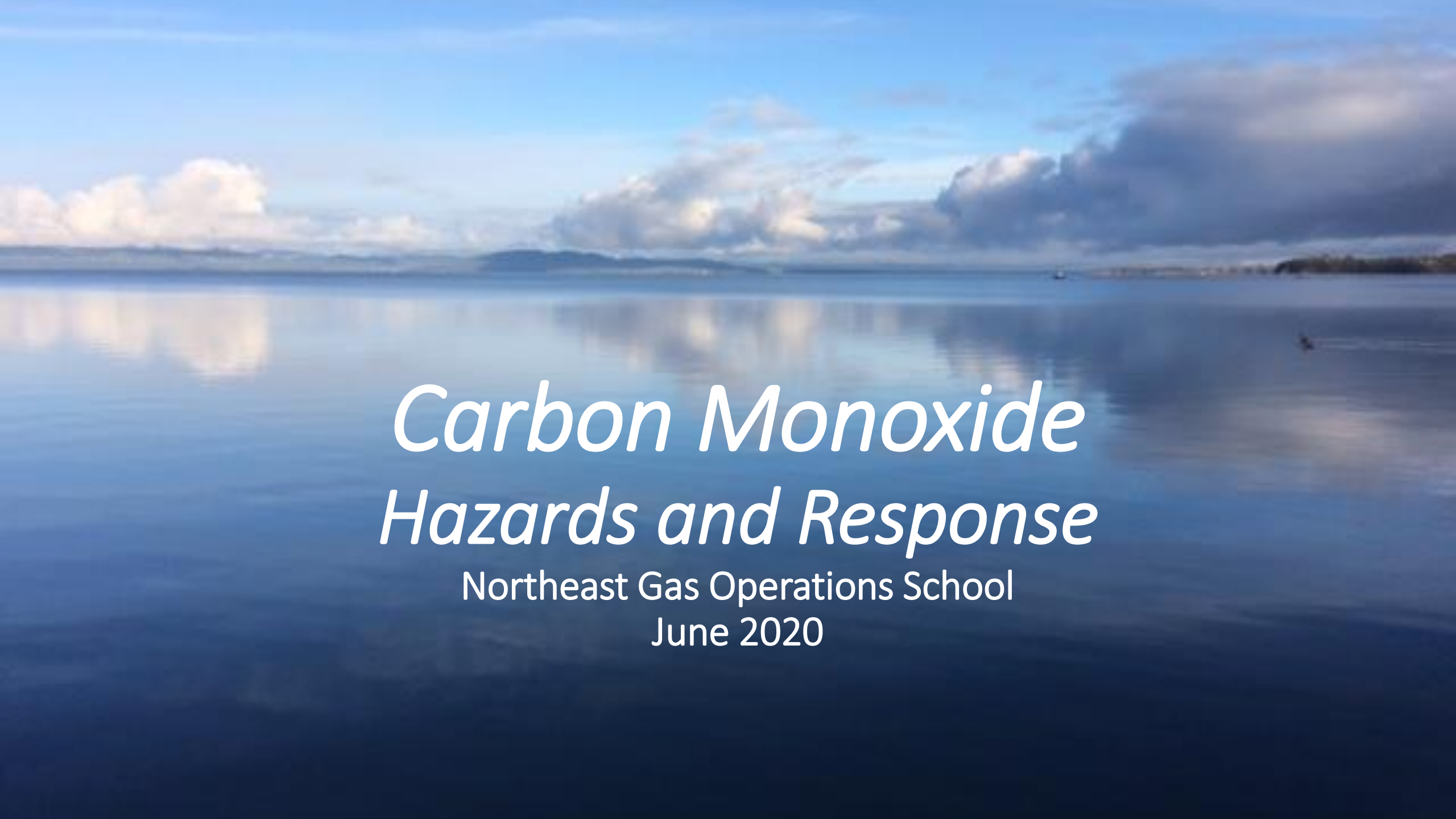
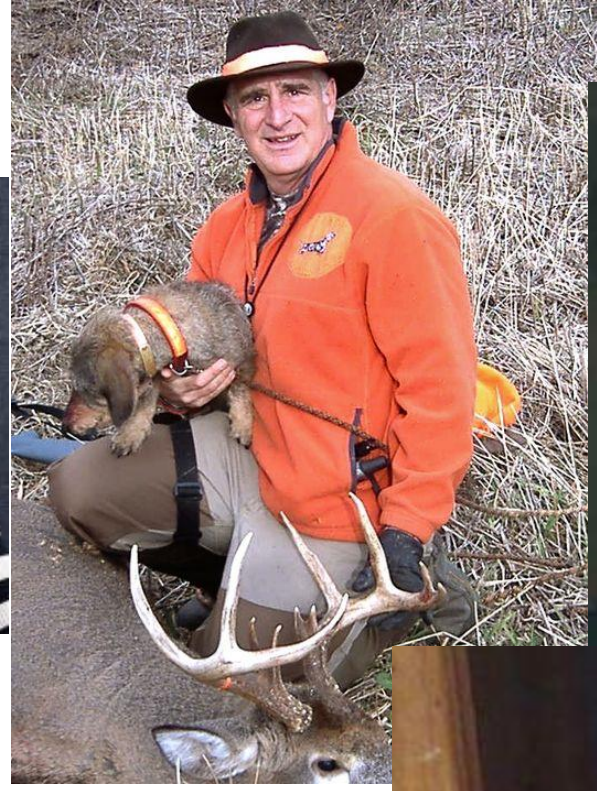
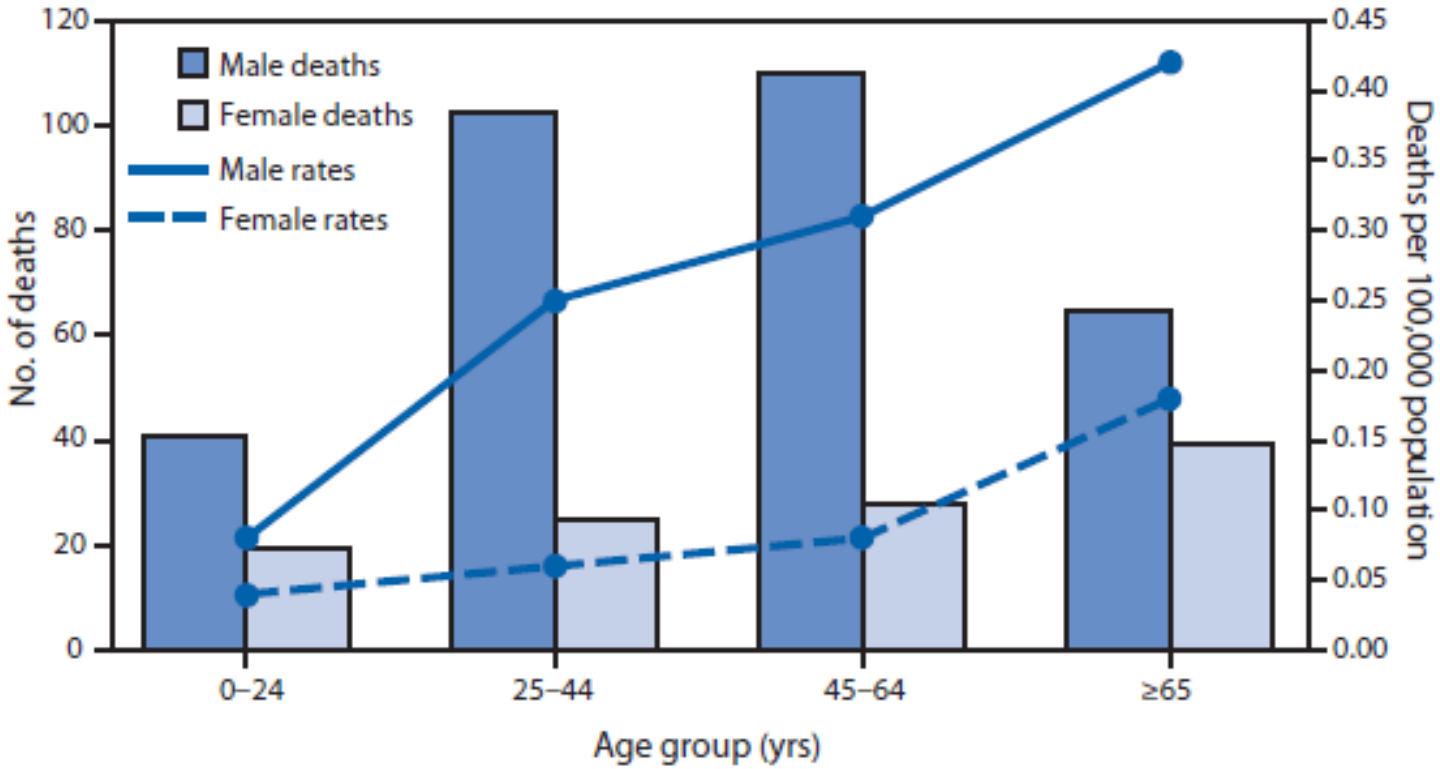


Carbon Monoxide
Hazards and Response

Northeast Gas Operations School
June 2020



January 24, 2014 / 63(03);65



Source: CDC Data 1999- 2010
Accidental CO Deaths

Equipment	Average U.S. Deaths (2013-2015)	%	
Portable Generators	65	41%	
Furnaces & Boilers	48	30%	
Portable Heaters	14	9%	
Engine-Driven Tools	10	6%	
Space Heater	6	4%	
Ranges and Ovens	5	3%	
Water Heaters	5	3%	
Other	7	6%	
Total	160	100%	

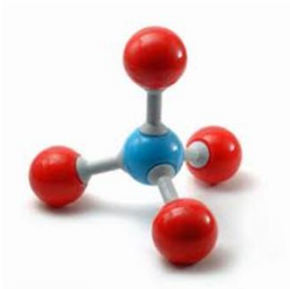
Source: CPSC 2015 Annual Estimates

Sources of Carbon Monoxide

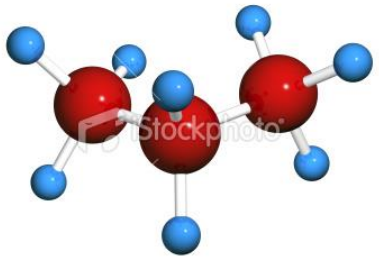
- Any carbon-based fuel
  - Natural, LP Gas
  - Oil, Kerosene
  - Wood
- Attached Garages
- Combustion Engines & Equipment
- Cigarette Smoking

Hydrocarbons Molecular Structure

- Methane CH_4



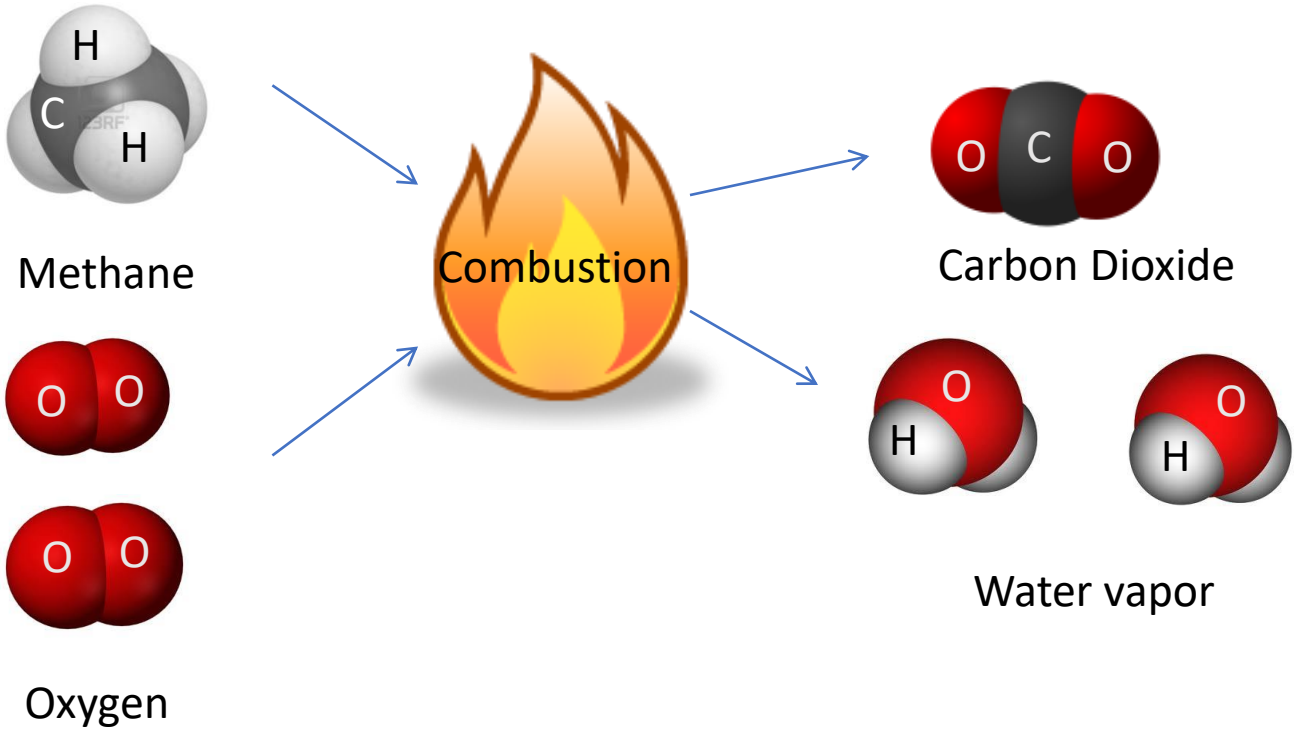
- Ethane C_2H_6
- Propane C_3H_8



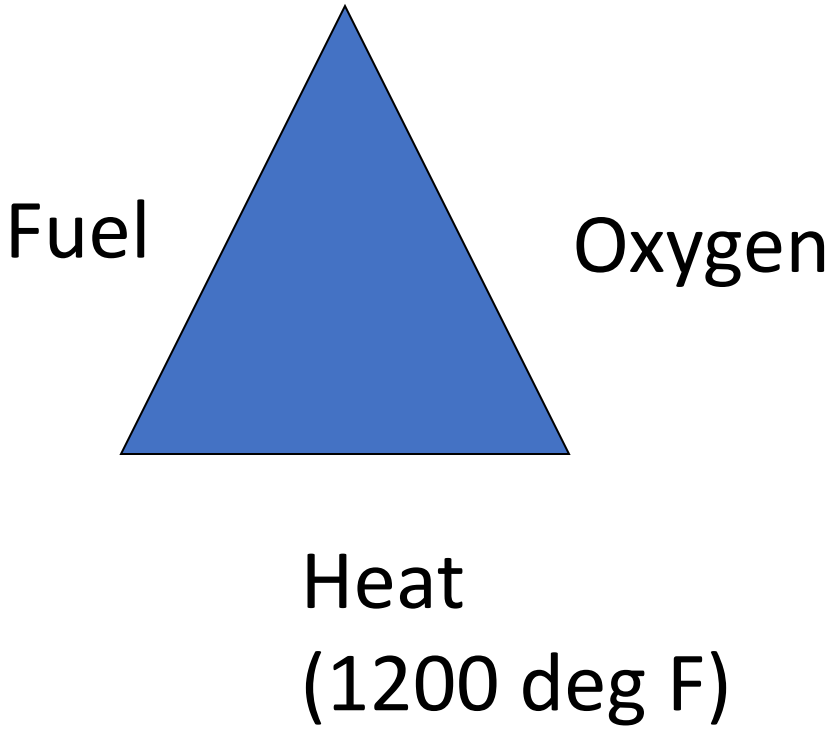
- Butane C_4H_{10}
- Pentane C_5H_{12}

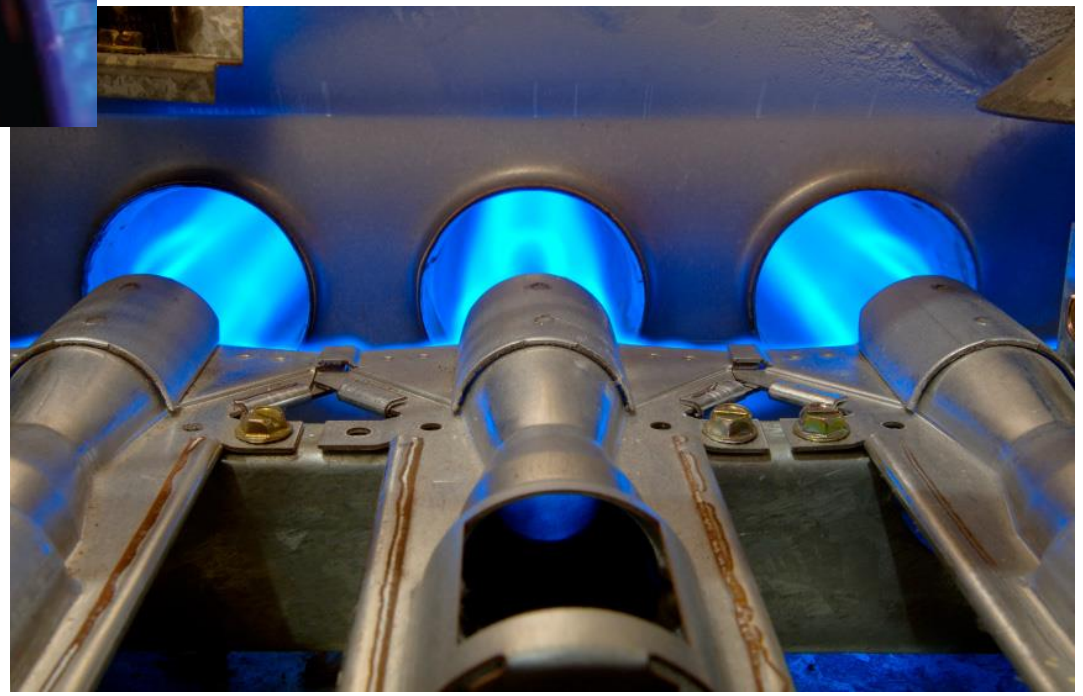
Combustion

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$



Proper Combustion





Perfect Combustion

$$CH_4 + 2O_2 = CO_2 + 2H_2O$$

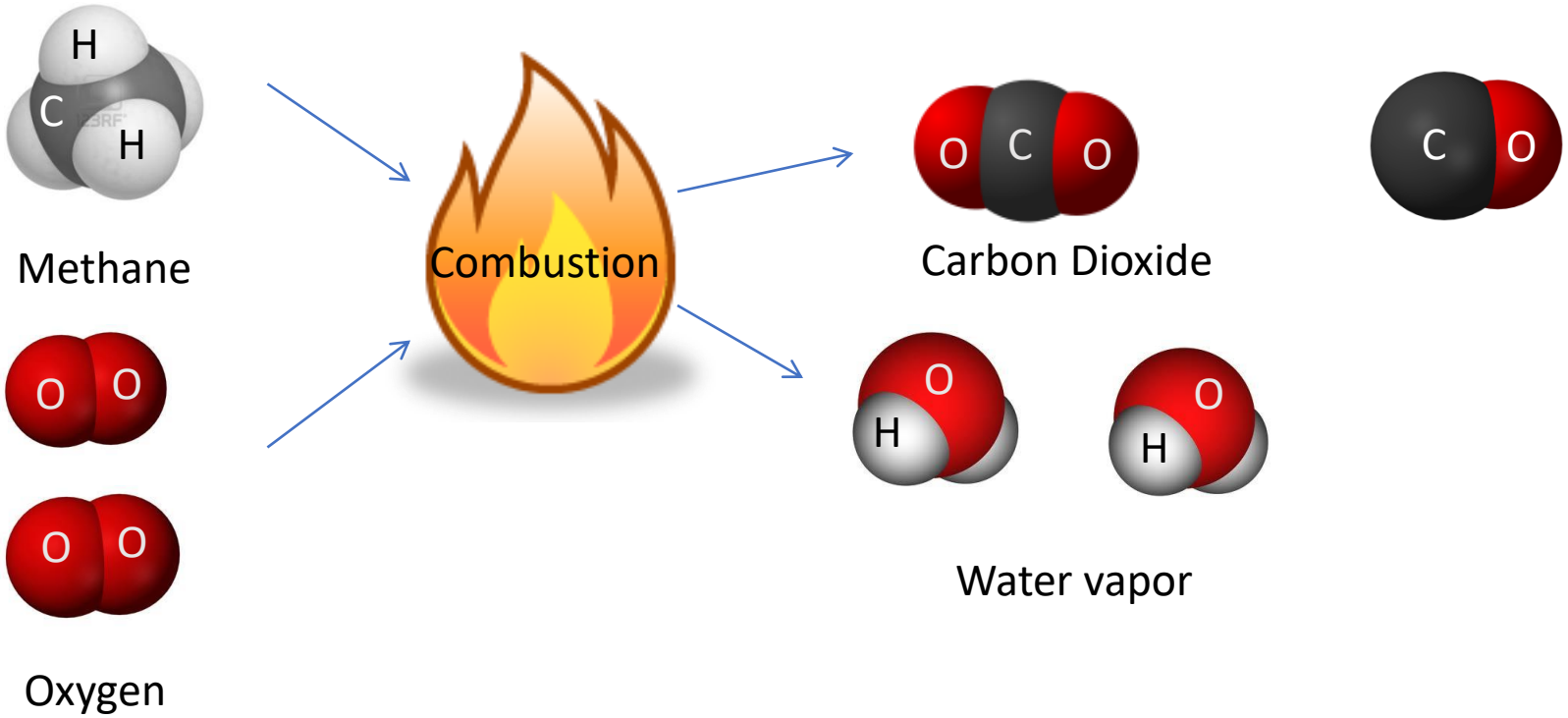
Incomplete Combustion

$$CH_4 + 2O_2 = CO_2 + 2H_2O + CO$$

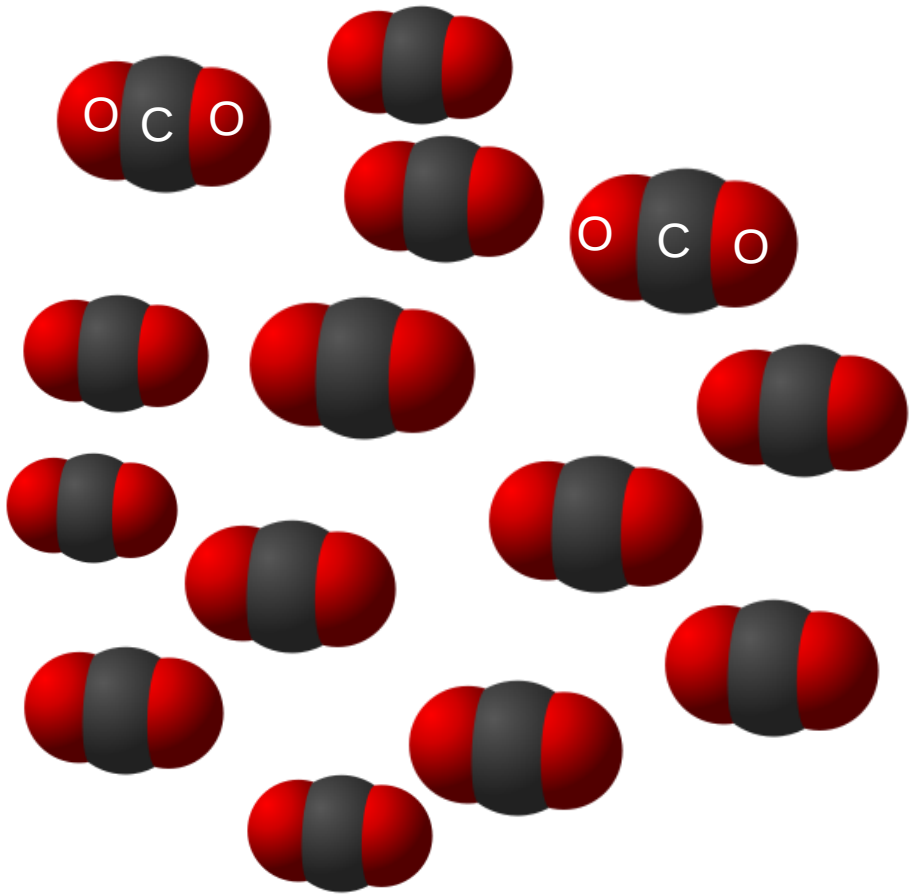
+ aldehydes + soot

Incomplete Combustion

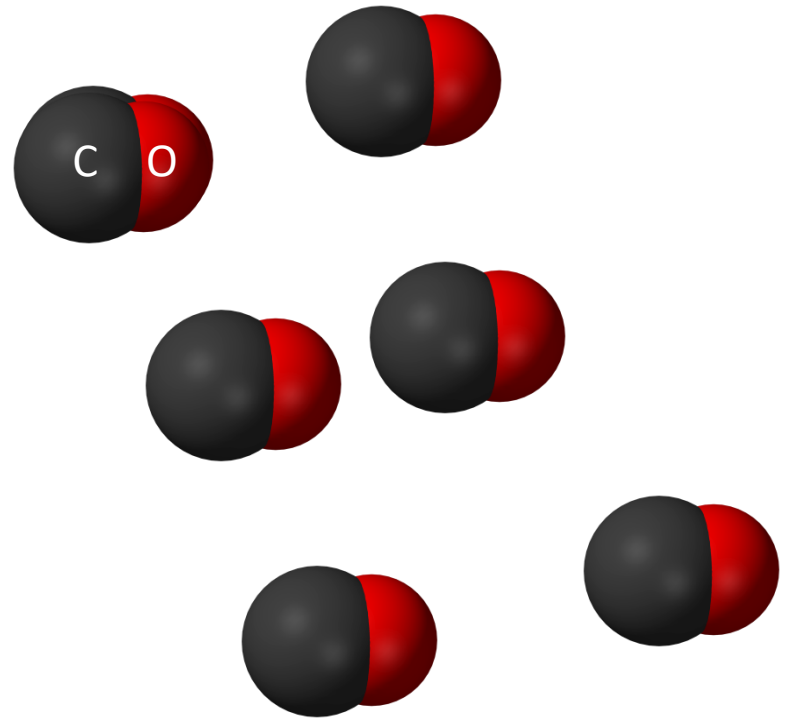
$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O + CO$$



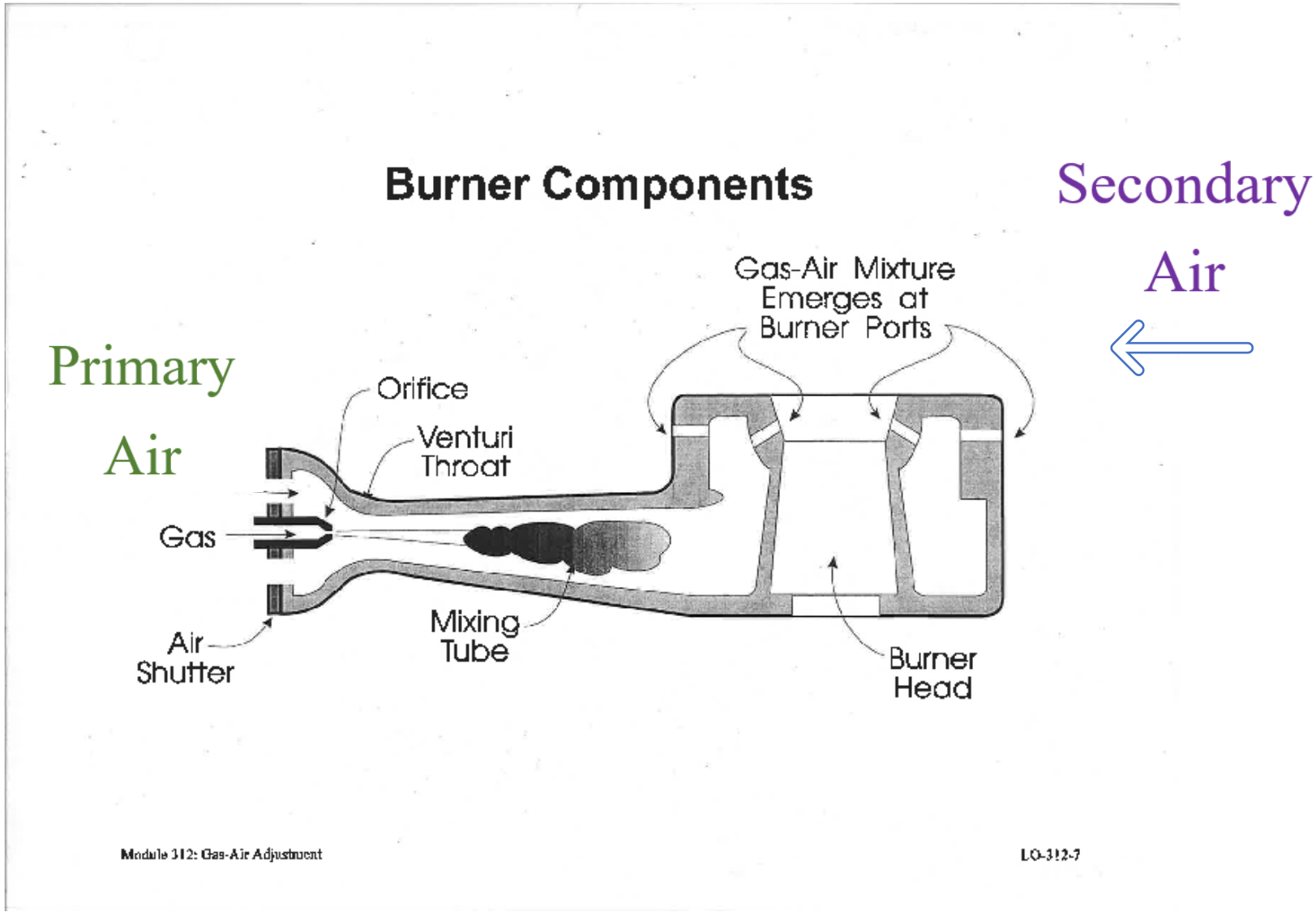
CO_2

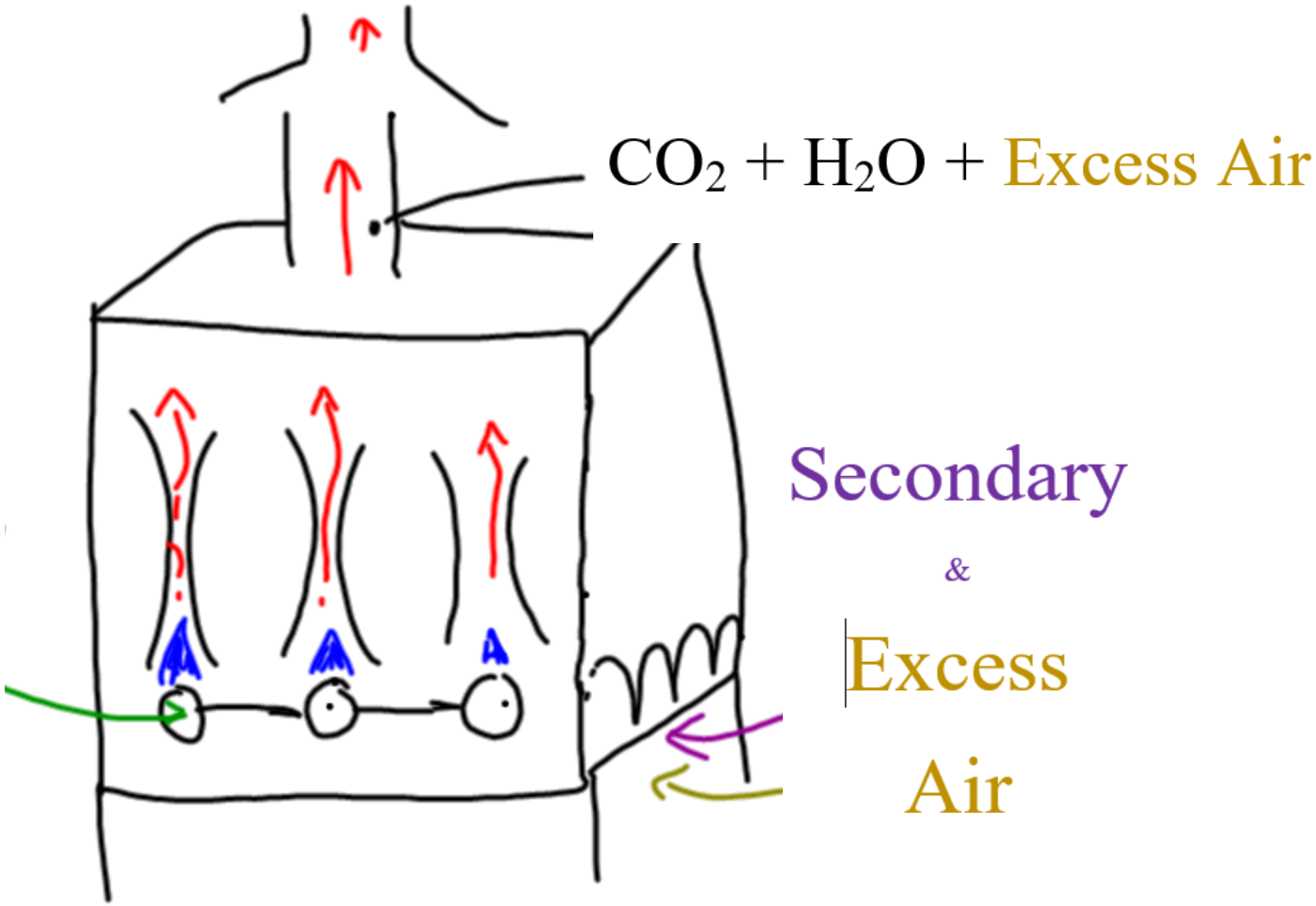


CO

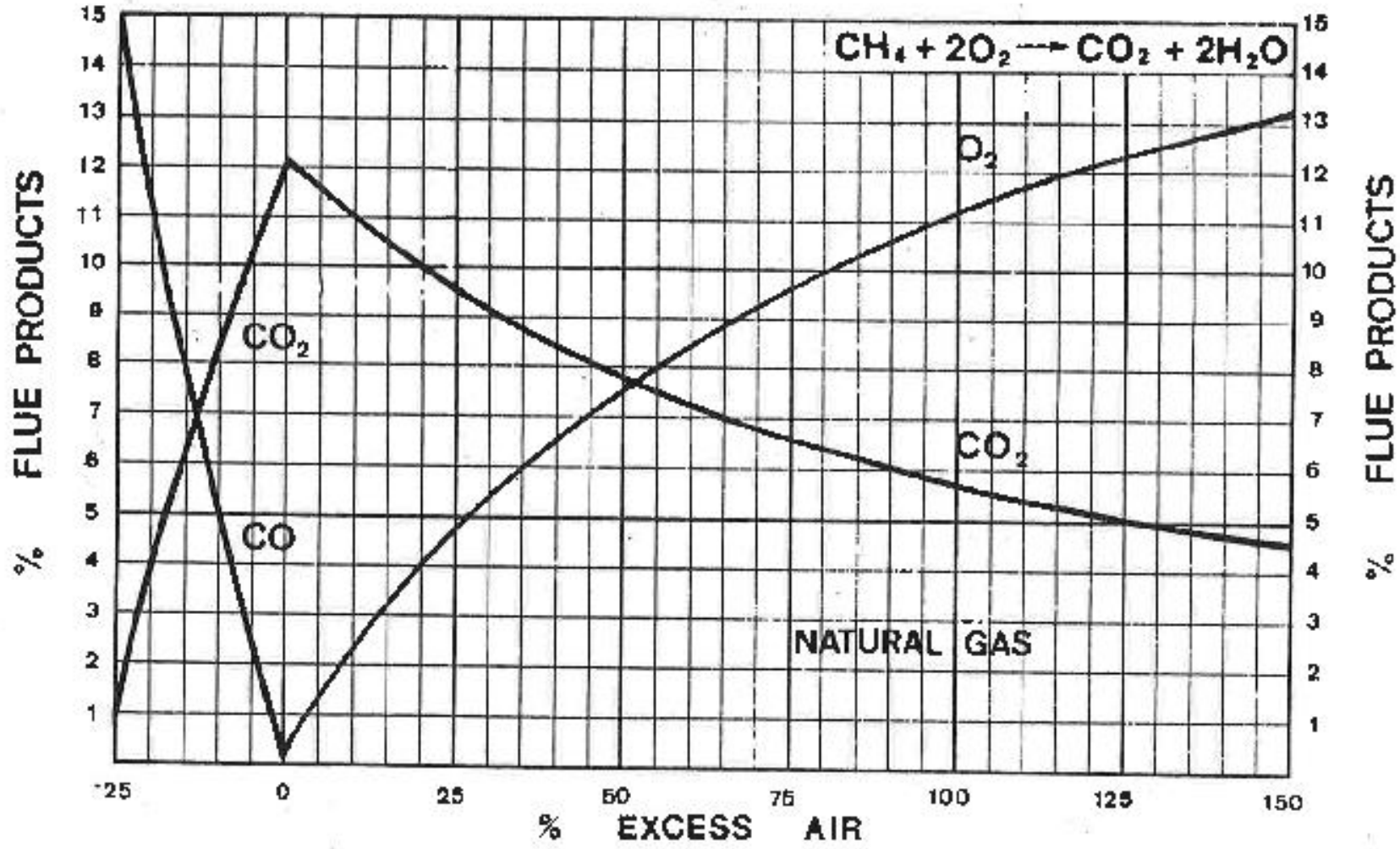


Atmospheric Combustion




$CO_2 + H_2O +$ Excess Air
Primary Air
Secondary & Excess Air

Mechanical Combustion



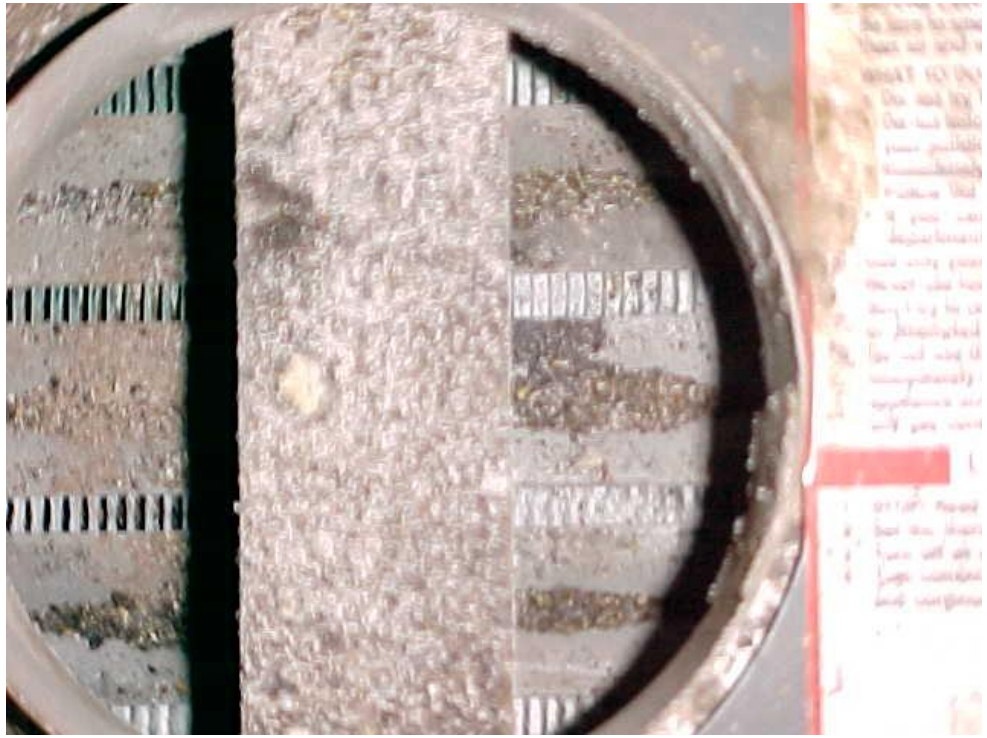
NATURAL GAS – 1023 BTU 0.658 SP. GR


NTi
Firetube Giant


testo
320 LX
t320
ADDRESS/SITE
Natural Gas
Measurement
118.4 °F Tstack
4.8 % O2
44 ppm CO
9.02 % CO2
89.5 % Eff net
26.5 % ExAir
Options
Clipboard
esc

Specific Causes

- Lack of Combustion Air

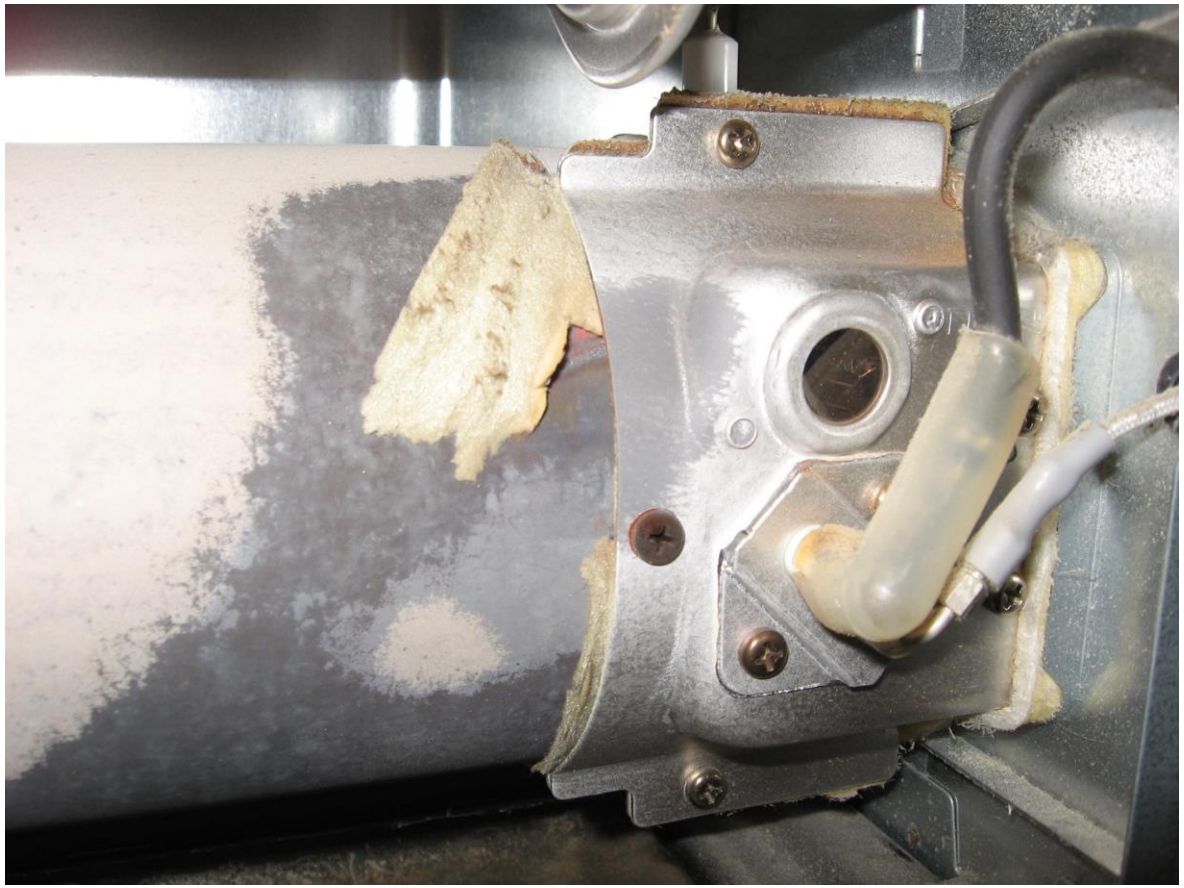


Specific Causes

- Cross Contamination
  - Blocked Chimneys and Vents
  - Separated Vents
  - Negative Draft Conditions

Specific Causes

- Cracked Heat Exchangers
- Leaking Gaskets



Specific Causes

- Exceeding Rated Input
- Flame Impingement

Warning Signs

- Yellow Flames
- Unstable Flames
- Soot
- High Humidity Inside
- Rotted Vents or Chimneys
- Dying Plants

Properties of Carbon Monoxide

- Odorless
- Poisonous
- Flammable (12% to 74% range)
- Specific Gravity = 0.97
- Heating value (321 btu/cubic foot)

Permissible Levels in Air

0 ppm	Normal Background
9 ppm	ASHRAE, EPA/NAAQS
35 ppm	OSHA 8 Hour Limit
200 ppm	OSHA Ceiling (15 minutes) Headache in 1 - 3 hours
4000 ppm	Fatal in less than 1 hour

Permissible Levels in Flue Gases

< 50 - 100 ppm	Normal Background
< 400 ppm AF	ANSI Standards for furnaces and boilers
> 200 ppm	Vt. Gas red tags and locks out

Looks Pretty Good Huh?
Let’s Check the Attic.

OOPS !

CO Poisoning

- CO is absorbed through the lungs
- Attaches to hemoglobin and displaces O_2
- Reduced Oxygen affects:
  - Brain
  - Heart
  - Muscles

Symptoms

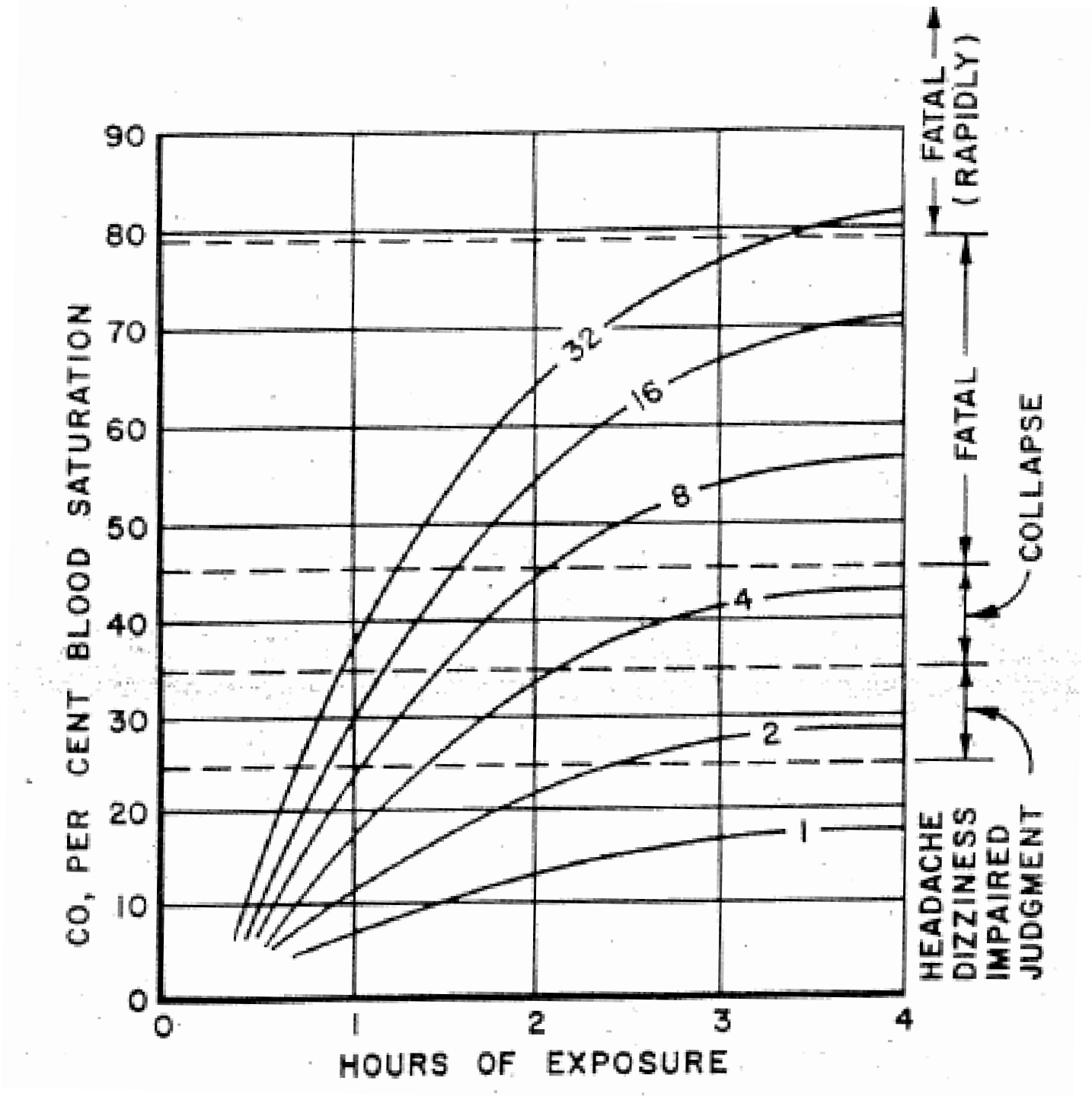
- Headaches
- Nausea
- Aggressiveness
- Effects can be permanent

Exposure (time)

Concentration

Air (ppm)

Blood (%)


CO, PER CENT BLOOD SATURATION
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
HOURS OF EXPOSURE
32
16
8
4
2
1
FATAL (RAPIDLY)
FATAL
COLLAPSE
HEADACHE
DIZZINESS
IMPAIRED
JUDGMENT

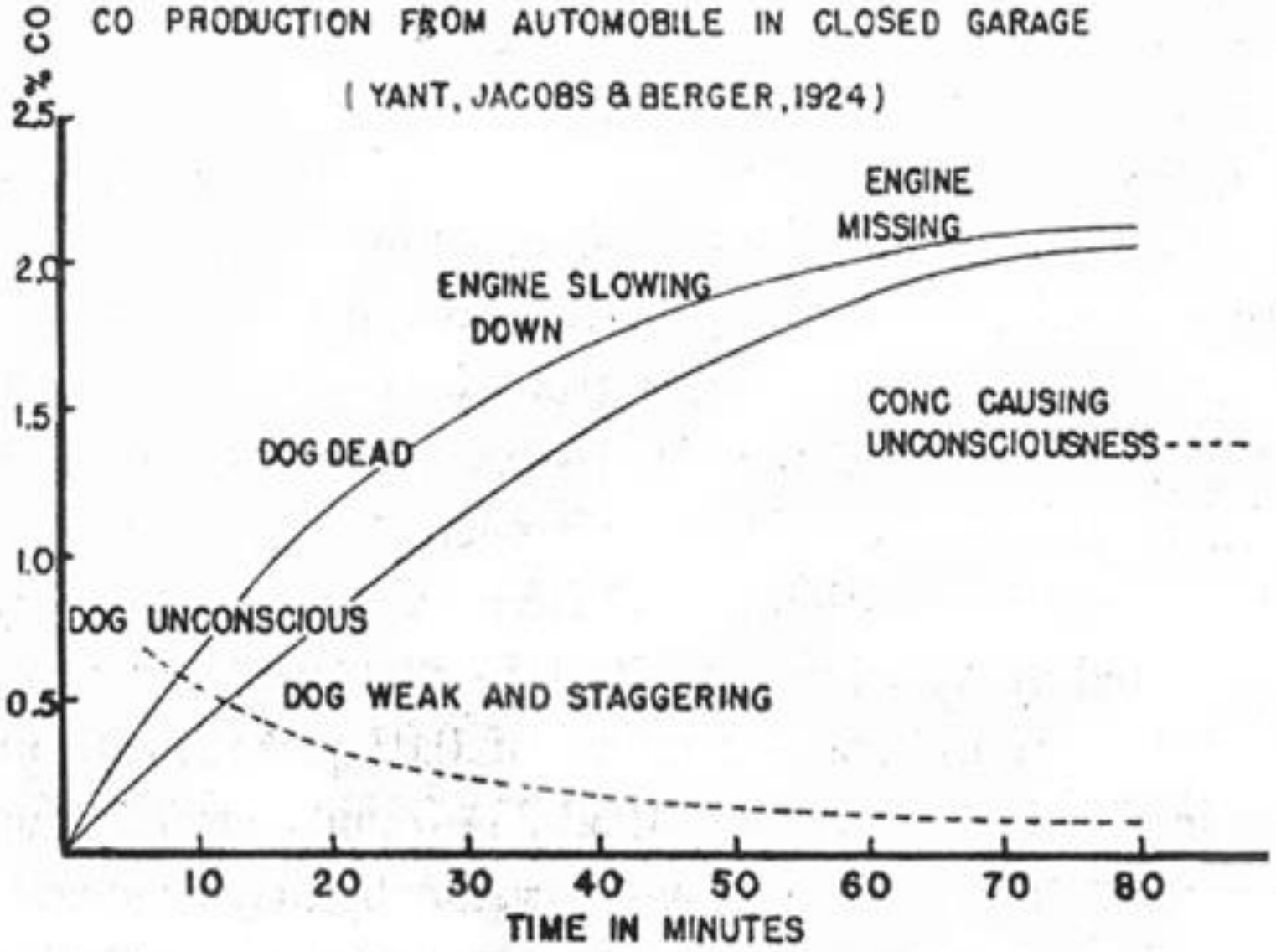


FIGURE 7.–Accumulation of CO in a closed garage from a running motor, and its effect on the functioning of the engine and on a dog.

Treatment

- Fresh Air
  - 4 - 6 hour half-life
- Oxygen
- Hyperbaric Oxygen Treatment
  - reduce cerebral edema and cranial pressure
  - maintains oxygen delivery to tissue

VGS Alarm Response

- 160 calls per year
- Mostly find no CO present
- Many legitimate alarms
- Major Causes
  - Car exhaust from attached garages
  - detector malfunctions

Four Point Program

- Training
- Appliance Installation and Maintenance
  - annual inspections & CO check
- Public Education
- Detection

- *No matter what we do……*


AP

Carbon Monoxide Investigations

Note: These procedures are guidelines and are not intended to cover every conceivable hazard. They should only be performed by qualified personnel equipped with a calibrated carbon monoxide detector.

1. **Safety first!** Determine if anyone has symptoms of CO exposure. If so, call 911.

2. **Measure**. If no one is ill, turn your CO detector on and zero it in fresh air. Enter the building and observe readings. If readings above 35 PPM are detected, open the windows and doors and have everyone, including yourself, exit the building. Contact the fuel supplier or other possible sources.

3. **Vent the building**. Allow sufficient time for the building to ventilate, re-enter the building, and take new readings. If the readings remain above 35 ppm, disconnect the fuel source and leave the building until the readings dissipate.

4. **Investigate.** If the readings are below 35 ppm, proceed with the investigation. Look for combustion sources that may have produced the CO readings. Possible sources include:

    a. Automobiles, generators, snow blowers, forklifts, etc.
    b. Heating and water heating equipment
    c. Gas stoves, charcoal grills.

5. **Operate appliances.** Turn combustion appliances off, then turn each one individually and take CO readings. CO readings should be within ANSI and manufacturer's specifications. If all appliances operate properly while running alone, turn on all appliances. Allow everything to operate for several minutes with the doors and windows closed.

6. **Be thorough**. You must allow sufficient time for any combustion or draft problems to manifest themselves. It may take hours for the combustion or venting process to become affected by a lack of adequate combustion air.

7. **Duplicate conditions.** Try to duplicate or evaluate the conditions at the time the CO was detected.
   a. Was it windy? Was it extremely cold?
   b. Were the doors and windows closed for a long period of time.
   c. Are there any devices such as exhaust fans or clothes dryers that could create negative pressures within the building? If so, operate them while performing your tests.

8. **Check neighboring buildings**. The carbon monoxide could be coming from elsewhere.

9. **Do not assume that there was only one source of CO**. If high CO readings are detected from any appliance, make adjustments or repairs and re-test for CO.

10. **Inspect appliances.** Inspect all vent systems from heating appliances for proper installation, condition, draft, clearances from windows and anticipated snow line, proper materials and supports.

11. **Perform a final test.** Close all doors and windows and allow the equipment to operate for a sufficient time to ensure that no further problems are encountered.

12. **Install carbon monoxide detector.** Ensure detectors are installed on every floor near the sleeping areas. Document the results of your investigation.