Mec Notes

NH Office of Professional Licensure and Certification. – OPLC

License and Renewal Office

7 Eagle Square

Concord, NH 03301

customersupport@oplc.nh.gov

603-271-2152

Monday thru Friday 8am – 4pm

NH Mechanical License Laws – RSA 153:27 – 153:38

Rules for Mechanical License Laws

Formally: Saf – Mec 100-600

Currently: Mec 100-900

Mec-100: Organizational Rules

102.03 "Domestic Appliance Technician"

Any person engaged in the installation, servicing, and repair of LP or Natural Gas residential domestic appliances.

Limited to:

1. Clothes dryers and their venting systems
2. Stove tops
3. Stoves & Ranges and their venting systems
4. Outdoor cooking equipment
5. Pool heaters

102.04 "Fuel Gas Fitter"

1. Fuel gas piping installer (HVAC-134 & 135)
2. Fuel gas installation technician (HVAC 230)
3. Fuel gas service technician (HVAC 230)
4. Hearth systems installation technician and service technician (fireplace or gas log)

102.06 "Fuel Gas Installation Technician" (Tier 2) (Equipment)

Any person engaged in the installation of LP or Natural Gas appliances or equipment.

From the POD to the residential or non-residential heating systems, water heating systems, generator, or kitchen equipment.

102.07 "Fuel Gas Piping Installer" (Tier 1)

Any person engaged in the installation of LP or Natural Gas Piping.

From the POD to the inlet of the residential or non-residential heating systems, water heating systems, generator, or kitchen equipment.

102.08 "Fuel Gas Service Technician" (Tier 3)

Any person engaged in the servicing or repair of LP or Natural Gas appliances or equipment.

From the POD to the residential or non-residential heating systems, water heating systems, generator, or kitchen equipment.

102.09 "Fuel Gas Trainee"

Any person engaged in the process of meeting the licensing requirements shall work under the supervision of a licensed fuel gas fitter on the repair or installation of LP or Natural Gas appliances or equipment.

From the POD to the residential or non-residential heating systems, water heating systems, generator, or kitchen equipment.

102.16 "Point of Delivery" (POD)

Outlet of the natural gas meter or 1st stage LP regulator

102.17 "Supervision"

Under the direct supervision of master or journeyman plumber or licensed fuel gas fitter

103.01 Composition of the Mechanical Board

8 members appointed by the Governor's council.

1. 2 licensed journeyman or master plumbers, actively working in the field.
2. 2 licensed fuel gas fitters, actively working in the field (1 shall represent LP industry)
3. 1 certified heating equipment installer or service tech
4. 1 licensed master plumber who also is a licensed fuel gas fitter, actively working in the field.
5. 1 public member who is not associated with plumbing or HVAC trades.
6. 1 certified water treatment technician, who will be a nonvoting member.

Mec 300: Initial Licensing

301.17 Relevant Field Experience

With respect to oil heating, the actual trade related functions of the installation and maintenance of.

- Piping Systems
- HVAC Systems
- Appliances and Appurtenances
- Fuel Oil Burning Equipment
- Water Distribution Systems

Not otherwise required by the licensing functions

301.26 Proof of successful completion of educational training of a formal educational program

Means either a certificate of completion, whether electronic or hard copy, including wallet cards or a course roster certified by the approved seminar provider for the course.

302.02 Age Requirement

NH Gas Fitter License: not less than 18 years of age

Trainee Registration: not less than 16 years of age

302.03 Term of Individual Licensure *(Revised 9/23 to RSA 310:8 II)*

License shall be valid for 2 years from the date issuance.

302.04 Term of Business Entity Licensure

The initial business entity license shall be issued for 2 years and shall expire on the last day of January.

303.06 Welding Exemption

Welders who are fitting gas piping are not required to hold an NH Gas Fitters License. However, they need to be under the direct supervision of a licensed fuel gas fitter or master plumber.

305.02 Requirements for Initial Individual Fuel Gas Fitter Licensure as a Fuel Gas Piping Installer (Tier 1)

1. Proof of successful completion of a minimum of 60 hours of educational training.

2. Pass the fuel gas piping installers examination with minimum 70% grade

3. A minimum of 1000 working hours of on-the-job training

305.03 Requirements for Initial Individual Fuel Gas Fitter Licensure as a Fuel Gas Installation Technician (Tier 2)

1. Proof of successful completion of a minimum of 100 hours of educational training.

2. Pass the fuel gas piping installers examination with minimum 70% grade

3. A minimum of 1000 working hours of on-the-job training

305.04 Requirements for Initial Individual Fuel Gas Fitter Licensure as a Fuel Gas Service Technician (Tier 3)

1. Proof of successful completion of a minimum of 140 hours of educational training.

2. Pass the fuel gas piping installers examination with minimum 70% grade

3. A minimum of 2000 working hours of on-the-job training

Mec 400: Continued Status

401.01 Continuing Education Course

A course approved by the mechanical licensing board for the further education of licensed fuel gas fitters and plumbers in New Hampshire.

404.01 Obligation to complete Continuing Education

(a) To be eligible for license renewal, individuals shall complete no fewer than 6 hours of continuing education in every 2-year licensing cycle.

(1) A board approved seminar teaching continuing education

(2) A comprehensive training session sanctioned by the board or board approved seminar.

Mec 500: Fees

501.01 Initial Fuel Gas Fitting Fees

(d) For initial fuel gas fitting license with Fuel Gas piping installer, installation tech, and service tech endorsement. ***$190.00***

501.03 Fuel Gas Fitting Renewal Fees

(d) Renewal fee for a 2-year fuel gas fitting license with Fuel Gas piping installer, installation tech, and service tech endorsement. ***$180.00***

501.04 Fuel Gas Fitting Trainee Registration Fee

(b) Renewal fee for a 2-year fuel gas trainee registration ***$80.00***

501.05 Late Renewal and Reinstatement Fees

(a) For late renewal of Fuel gas fitting license past 30 days up to 12 months***: $25.00 per month.***

(b) For late renewal of Fuel gas fitting trainee license past 30 days up to 12 months***: $10.00 per month.***

(c) For licensing reinstatement that have been expired past 12 months, or are reinstated resulting from suspension or revocation: ***$350.00***

502.01 Initial Mechanical Business Entity License Fees

(a) For 2-year mechanical business entity which employs 1 to 5 fuel gas fitting techs:

$190.00

(b) For 2-year mechanical business entity which employs 6 to 20 fuel gas fitting techs:

$300.00

(c) For 2-year mechanical business entity which employs 21 and more fuel gas fitting techs: ***$460.00***

502.02 Mechanical Business Renewal Fees

(a) For 2-year mechanical business entity which employs 1 to 5 fuel gas fitting techs:

$190.00

(b) For 2-year mechanical business entity which employs 6 to 20 fuel gas fitting techs:

$300.00

(c) For 2-year mechanical business entity which employs 21 and more fuel gas fitting techs: ***$450.00***

Mec 600: Professional Standards

602.01 Imminent threat to life safety

Any condition, operating feature, or combination of that when energized presents a hazard that could cause property damage through fire or explosion, health or life safety hazards to the occupants, residents, or property owners.

603.01 Obligations of Mechanical Business entities, Individual Fuel Gas Fitting Licensees, and Trainees.

(a) Maintain proficiency in NH mechanical licensing laws, codes, and standards as they apply to each discipline.

(b) Cooperate with local code enforcement personnel as required.

(c) Give accurate and complete information when asked to do so as a part of an investigation or hearing.

(d) Not represent themselves as a master or journeyman plumber when registered as an apprentice.

(e) Not represent themselves as a licensed fuel gas fitter when registered as a trainee.

603.02 Additional Obligations of Mechanical Business entities, Individual Fuel Gas Fitting Licensees, and Trainees.

(a) Obtain local permits and inspections as required.

(b) Accurately inform customers or potential customers in writing about any foreseeable hazards and potential code violations that may pose a risk to personal safety.

(c) Act in good faith to recognize, repair or remove from service any appliance or system that presents an imminent threat to health or life safety or to the property.

(d) Honor any warranty of products or services whether implied or in writing as apart of services, goods, or both to customers in a timely and proficient manner.

604.01Misconduct

(a) The participation or practice of fraud or deceit in procuring a license for oneself or for benefit of others.

(b) While licensed, any conviction of:

1. A felony

2. Any criminal offense involving injury or the risk of injury

3. Any criminal offense involving dishonesty

(c) Unprofessional conduct, dishonorable conduct worthy of affecting the practice of fuel gas fitting.

1. Any violation of the adopted rules of the mechanical board

2. Any violation of RSA 153:27 through 153:38

3. Any violation of current state codes and or the state safety fir code.

4. Any violation of a local code ordinance more stringent than state codes

5. The allowance of fuel gas fitting work by a non-licensed individual.

6. The allowance for fuel gas fitting work by a trainee in violation of the trainee agreement listed in Mec 300 & Mec 400.

(d) Negligent or willful acts performed in a manner inconsistent with the health and safety of the persons under the care of the licensee.

(e) Addiction to the use of alcohol or drugs to a degree which renders the licensee unfit to practice fuel gas fitting.

(f) Mental or physical incompetence to practice fuel gas fitting,

(g) Willful or repeated violations of RSA 153:27 through 153:38 and Mec 100-600

(h) Suspension or revocation with out reinstatement of a license similar the one issued by another jurisdiction,

(i) Failure of a licensee to recognize, repair, or remove from service any appliance, fixture or system that presents an imminent threat to the health or life safety of a property owner, resident, tenant, or visitor to the property, facility, or building which the licensee discovers in the performance of their duties.

604.02 Sanctions

(a) Disciplinary measures available to sanction misconduct shall be:

1. A reprimand in the form of a letter to the licensee and placed on file for a period of not less than 1 year.

2. Probation period to be determined by the mechanical board.

3. ***Suspension, limitation, or restriction of license for a period of up to 5 years.***

4. ***Revocation of license or certification***

5. Requiring the licensee to participate in a program of continuing education in the areas in which he or she has been found deficient.

(b) Disciplinary measures specified in (a) above shall be served by the issuance of a formal "Notice of Violation" or "Written Warning" served in hand by a mechanical inspector. The served licensee shall take immediate actions required to correct the deficiencies noted on said notices or warning forms.

605.03 Limitations on Number of Trainees

No more than 2 trainees for every one licensed fuel gas fitting tech.

608.01 Notification of Hazardous Conditions

(a) Shall immediately notify the homeowner, property owner, or occupant of any condition that renders any appliance, fixture, or system that presents a hazard, threat, or both, to personal or life safety.

(b) If possible, without causing destruction to the appliance, fixture, or system. The licensee shall be required to remove from service the appliance, fixture, or system that presents a hazard, threat, or both, to personal or life safety. By closing the fuel supply valve and deactivating the power source.

(c) Any appliance, fixture, or system that has been removed from service shall be labeled with a warning sign, label, or tag clearly stating, "DO NOT OPERATE" (Red Tag)

(d) The practice of removing the appliance, fixture, or system from service shall not be permitted in the absence of an imminent threat to life safety.

NOTE: Any issues, concerns, or pushback from customer. Immediately contact AHJ.

Chapter 1-4 Notes

The state of NH is currently enforcing the 2018 edition of NFPA 54.

- Use the table of contents (Beginning) and the Index (End) to help find information in the code book.

There are 13 chapters: Chapters 1-8 are covered in the HTC GPI class, Chapters 9-13 in HVAC 230 at MCC. There are 11(a-k) non-mandatory annexes.

- Pg 116: Annex material is for informational purposes only. It is informal material about the mandatory provisions of the code.
- *: an asterisk after a code paragraph number means advisory annex material can be found in annex A.

Annex A is explanatory material of the code paragraph. (CPN)

A formal interpretation of the code can be obtained by sending an official request to the appropriate technical committee of NFPA .

Chapter one provides administrative requirements for five areas: Scope, Purpose, Retroactivity, Equivalency, and Enforcement.

Scope - Includes what is covered and what is not.

- Covered 1.1.1.1 A-F

(F) - The safe operation of appliances is met when the following conditions are met:

- The necessary amount of gas is provided at the intended pressure.
- Sufficient air is provided to completely burn the gas.
- The installation is such that heat produced by the appliance does not cause a building fire.
- The products of combustion are removed from the building, either by a flue, vent, or small appliances by the normal air exchange in a building.

Not Covered 1.1.1.2 (1) - (20) Shall not apply to.

You can have more than one fuel gas in a building.

1.1.2 - Other Standards:

- In addition, state or local fuel gas code modifications or amendments shall be referenced.

1.3 - **Retroactivity.** Ex:

- If a gas piping system was installed per code requirements in 2000, and now due to new or revised material it no longer meets code, we are not required to make changes . However, if a question on retroactivity exists, consult the local AHJ.

Chapter 2 provides the reference publications (a list of the codes and standard referenced in NFPA 54) we shall meet the requirements of to comply with NFPA 54.

The difference between listed and labeled is:

- Listed means that either the equipment, material or service meets appropriate standards and has been tested and found suitable for a specified purpose. It can be found on a list stating such . Labeled means the same but its label is attached.

Shall indicate a mandatory requirement.

The between accessible and readily accessible is:

- Accessible means access is available with the removal of a panel, door, or other covering . Readily accessible means direct access without removing anything.

Chapter 4 - **General**

- Provides information such as who is allowed to do the work, what must be done prior to and following an interruption of gas service, and the requirements to prevent accidental ignition while performing repairs.

If we are making repairs or alterations to an existing gas piping system and cannot complete the work before we leave for the day, the system shall be left in safe condition.

Safe Condition:

- This is accomplished by ensuring all pipe-ends and valves are capped/plugged. Shut off valves should be tagged "out of service" and locked.

Acetylene torches or other flammable liquids used by an installer shall not be left within the premises from the end of one working day to the next .

NFPA 54- Chapter 5

Meters, Regulators, and Devices Notes:

Interconnections Between Gas Piping Systems:

1. Supplying separated users
    a. Apartment buildings, Condo's, Townhouses.
2. Standby Fuels

a. More than one fuel used

i. Three-way valve

Meters:

1. Purpose
    a. Gauge the volume of fuel gasses
2. NFPA 54-Applicability
    a. 5.7* - Premise owned meters
3. Two common types
    a. Diaphragm - Residential, Light commercial
    b. Rotary- Large commercial, industrial, More than 1 million BTU's
4. Capacity
    a. Accommodate maximum expected pressure: PSI and "W.C
    b. Permissible Pressure Drop: .5" W.C
5. Location
    a. Gas meters shall be installed so they are readily accessible for:
        i. Examination
        ii. Reading
        iii. Replacement
        iv. Maintenance
6. Identification
    a. 5.7.5 - Stamped with metal tag
7. Clocking a meter
    a. Firing rate (BTU/HR) = Heating value (BTU/Cu.Ft) x 3600 Divided by timed seconds.

Gas Pressure Regulators:

1. Purpose

a. Supply A constant and regulated Pressure
    i. Gas appliances require a continuous gas supply at a properly adjusted and maintained pressure to provide clean and efficient operation.
b. Compensate for two variables
    i. Inlet Pressure
        1. Fluctuations in tank pressure - Temperature change
            a. First stage regulator
    ii. System Demand
        1. Fluctuations in downstream demand- Appliance Demand
            a. Second stage regulator

2. Regulator Lock-up
    a. When system demand for gas stops, the regulator will close the seat disc onto the inlet nozzle, completely shutting off gas supply. Lock up pressure is not allowed to exceed 120% of factory setting. Per UL requirements.
3. Regulator Bounce
    a. System design pressure drops (What we size to accomplish)
        i. .5" W.C from P.0.D to all appliances while in peak demand.
        ii. Ex: ASP= 12" W.C no less than 11.5" W.C to inlet of all appliances gas valves.
    b. 1" W.C total bounce (.5" W.C above and below)
4. Regulator Relief Valve
    a. 5.9 overpressure protection devices
        i. A relief valve is required on all final stage gas regulators. It will vent excess gas pressures out of the regulator vent if needed
        ii. Pressure relief valve is integral to second stage regulator (LP gas) and service regulators (Natural)
        iii. Appliance gas valves rated for 14" W.C maximum working pressures can withstand 2.5 PSI without permanent damage.
5. Regulator Vent: Must always be clear and open.
    a. For proper regulator operation, air entering the regulator bonnet through the regulator vent allows the diaphragm to move freely.
    b. Two ways obstructed vents result in improper operation
        i. Diaphragm can't move freely and regulate the gas resulting in high pressures.
        ii. Will prevent the discharge of excess gas pressure from the relief valve.
    c. Installation Requirements
        i. Minimum distance from a source of ignition
            1. NFPA 54 - 3'
            2. Utility Companies - 4' 3.
            NFPA 58-5'
        ii. Minimum distance from building opening

1. 3'

iii. Minimum distance from combustion air intake

1. 5'

iv. Shall be designed/installed to prevent the entry of:

1. Water
2. Insects
3. Foreign Material

v. Underground tank installation vent requirements

1. Located under the cap
2. Minimum 2" above anticipated flood level

vi. Vent Piping Material

1. Inside
    a. Metallic pipe - Brazed connections
2. Outside
    a. Black Iron - Painted
    b. PVC - UV rated

6. Line pressure Regulators
    a. Appliances
        i. 2 PSI ASP with line pressure regulators located at all appliances
    b. Vent Limiters
        i. Remove the need to vent the regulator to the outdoors
        ii. Installed per manufacturer's I & 0. If required, must be installed in the horizontal, upright position.
7. Regulator Inspection
    a. Regular installation
        i. Every three years
    b. Corrosive environment
        i. Yearly
    c. Underground tank (1 st stage)
        i. During every fill
8. NFPA 54 Applicability
    a. 5.8* - Premise owned regulators
9. Identification
    a. 5.7.5

Devices:

1. Maintain safe gas installations
2. Over pressure Protection
    a. Typically to protect appliances from failed regulators

    b. A relief valve is required on all final stage gas regulators. It will vent excess gas pressures out of the regulator vent if needed
        i. Pressure relief valve is integral to second stage regulator (LP gas) and service regulators (Natural)
    c. Large Commercial and industrial applications have three other means
3. Back pressure Protection
    a. Industrial applications use mixing air and gas using compressed air.
        i. Prevent air/oxygen from entering. the gas piping system
            1. Common device is a check valve (only allows flow in one direction)
4. Low pressure protection
    a. Large commercial and industrial applications
        i. Ex: Gas compressors utilizing large amounts of gas can cause a reduction or vacuum to other appliances
5. Shutoff Valves
    a. Full-port are recommended
6. Excess Flow Valves
    a. Installed per manufacturer's 1&0
    b. Valve capacity
        i. 50% larger than maximum demand
        ii. Inlet and outlet > EFV size
    c. Can flow gas in both directions
    d. Can only stop the flow in one direction
    e. Activated by a clean break or rupture
    f. Tested yearly
7. Expansion and Flexibility
    a. Thermal expansion or contractions can cause excessive stress in the piping system
        i. Use piping strategies or appliance connectors to alleviate this stress.

Sizing Gas Piping Systems Notes

Gas piping systems sizing requirements and considerations:

1. General Considerations:

a. 5.4.1 Gas piping systems shall be of such size and so installed as to:
   i. Provide a supply of gas sufficient to meet the maximum demand
   ii. Supply gas to each appliance inlet not less than the minimum supply pressure required by the appliance.

b. A.5.4.1 Sizing of gas piping systems is dependent upon:
   i. Allowable loss in pressure from P.O.D to appliance(s)
   ii. Maximum gas demand
   iii. Length of piping and number of fittings
   iv. Specific gravity of gas
   v. Diversity factor
   vi. Foreseeable future demand

c. 5.4.4 Allowable Pressure Drop:
   i. Code only requires that with all appliances operating, no appliance receives less than the minimum inlet pressure required.

d. 5.5 Piping systems operating pressures:
   i. Maximum design operating pressure
      1. Inside a building-Anything more than 2 PSI need AHJ approval
         a. 5.5.1 - in NFPA 54
            i. 5 PSI
      2. Outside a building
         a. 1.1.1.1(8)
            i. Natural gas-125 PSI
            ii. L.P - 20 PSI

2. Maximum Gas Demand

a. 5.4.2 Maximum gas demand
   i. The amount of gas to be supplied is equal to the total system demand with all appliances operating at maximum input.
   ii. Natural Gas input ratings are in C.F.H - Cubic ft/hour (1CFH =1MBH)
   iii. Propane input ratings are in M.B.H
   iv. References available to determine appliance input rating.

1. A rating provided by the Manufacturer 2. Table 5.4.2.1 - Pg 117
3. S.G.S - Serving Gas Supplier
4. Qualified agency

b. Exception: Diversity Factor

3. <u>Sizing Methods:</u>

a. 5.4.3 gas pipe sizing shall be sized in accordance with one of the following:
   i. Pipe sizing tables or sizing equations in chapter 6
      1. Longest Length - Most common, easiest to perform
      2. Branch length - More accurate
      3. Hybrid Pressure - With CSST
      4. Pressure drop per 100'
   ii. Other approved engineering methods acceptable to the AHJ
   iii. Manufacturer's I & 0 instructions
      1. Sizing tables from listed system (Ex: CSST)

b. For gas piping systems with longer runs, greater demands, or higher pressure drops than indicated in sizing tables within NFPA 54 chapter 6, the sizing equations are provided in 6.4

<u>Sizing the Piping Systems:</u>

1. Using piping diagrams, (preferably Isometric) break the system piping into segments based on different maximum demands a pipe segment carries.
   a. Appliances branches identify as outlets using letters.
      i. Ex: Outlet A - Feds 1 appliance
   b. Common branches or mains identify as sections using numbers.
      i. Ex: Section 1 - Feed multiple appliances.
2. Start at the most remote appliances and work your way back to the P.O.D adding demands as appliance branches and common branches are added.
3. Every time the demand changes, you now have new pipe segments.
   a. Pay attention to fitting allowances for piping segments.
4. Every segment will need the length and maximum demand identified
5. Once all the segments have been identified and the length and maximum demand for each segment have been figured, you are ready to begin sizing the piping using any approved method .

<u>Using the Tables:</u>

1. Rarely will a distance or demand fall perfectly into a box in the sizing tables. We will always round up to the next length or pipe size. These charts provide the **Maximum** lengths or capacity for a specific pipe. (Ex: 27' round to 30')
2. Total effective length= measured length + equivalent length from fittings
    a. Equivalent length from fittings is only necessary to calculate when the "typical" fitting allowance is exceeded. (>4-90*s between P.O.D and appliance)
3. Table B.3.2 must be referenced and equivalent lengths added to segments exceeding the restriction.
    a. **Type of Gas**
        i. **Natural Gas:**
            1. Natural gas charts can be used when specific gravity is less than .7 if AHJ approves. Otherwise use table B.3.4 when other than.6
                a. 6.2(b) Schedule 40 metallic pipe (Black Iron)
                b. 6.2(i) Semirigid copper tubing (soft copper)
                c. 6.3(o) Corrugated stainless steel tubing (CSST)
        ii. **Propane (LP):**
            1. 6.3(d) Schedule 40 metallic pipe (Black Iron)
            2. 6.3(f) Semirigid copper tubing (soft copper)
            3. 6.3(h) Corrugated stainless steel tubing (CSST)
    b. **Type of Piping material:**
        i. **Black Iron:**
            1. If greater than schedule 40, Actual capacity will be less
        ii. **Soft Copper:**
            1. ID is based on Type K copper, which has the thickest wall therefore the smallest ID of all the copper types. This means if other types are used the ID will have a Greater Capacity.
        iii. **CSST:**
            1. EHD (Equivalent Hydraulic Diameter) is used. Manufacturers of CSST do not conform to a standard for determining ID for their piping. They must provide an EHD that can be used in the charts for sizing all CSST brands.
            2. The greater the EHD the greater the capacity
            3. The CSST charts assume 4-90* bends and two transition fittings, fitting allowance will need to be calculated if these restrictions are exceeded.

        iv. **ASP:**

1. Natural gas: 3.5 - 8" w.c
2. Propane: 11 -14" w.c

v. **Allowable pressure drop:**

1. Most common tables used are selected to maintain a maximum pressure drop of .5" w.c
    a. Industry best practice
2. For natural gas the typical inlet pressure to an appliance is 5" w.c, the appliance only needs 3.5".
    a. This allows for a 1.5 " w.c pressure drop
3. For L.P gas the typical inlet pressure to an appliance is from 11 -14" w.c, the appliance only needs 11 ".
    a. This allows for an up to 3" w.c pressure drop.

Longest Length Sizing Method:

1. For the longest length method, you will do what the name implies, use the longest length in the system piping to size **ALL** the piping, regardless of actual distance from the P.O.D
2. Identify the longest length from the P.O.D to the most remote outlet. Again, this distance will be used to size ALL the piping segments.
3. Start sizing the piping with the most remote outlet and work your way back to the P.O.D
4. Stay in the row for the determined total equivalent length and go right until you find a capacity> the maximum demand for that piping segment.
5. Once you find a capacity that will be sufficient go up the chart and determine the pipe size.
6. Do this for all pipe segments working your way back towards the P.0.D

Branch Length Sizing Method:

For the branch length method, you will size the **Sections** and **outlets** individually based on the longest TEL for that individual segment.

1. Start sizing the sections from the furthest section away from the P.O.D and work your way back.
2. Identify the longest length from P.0.D to the most remote outlet served by each section. This distance (TEL) Will be used to size that section.

3. Determine the maximum demand for each section.
4. Stay in the row for the determined TEL and go right until you find a capacity> the maximum demand for each section.
5. Once you find a capacity that will be sufficient, go up the chart and determine the pipe size.
6. Do this for all sections.

Sizing the Branches:

1. Start sizing the outlets from the furthest outlet away from the P.O.D and work your way back.
2. Each individual outlet's distance from the P.O.D will be used to size each individual outlet's pipe segment.
3. Each individual outlet's demand will be used to size each individual outlet's pipe segment.
4. Using the chart, find the row for the determined TEL for each individual outlet.
5. Stay in the row for the determined TEL and go right until you find a capacity> the maximum demand for each outlet.
6. Once you find a capacity that will be sufficient, go up the chart and determine the pipe size.
7. Do this for all outlets

Gas Piping Installation Requirement Notes

1. Underground Piping

a. 7.1.1

i. When gas piping is installed underground, we shall provide clearance from any other underground structure.

1. Foundations
2. Roots
3. Plumbing/Electrical piping

ii. Plastic piping shall be installed with clearance or insulation from any heat source. Ex: Pool heaters, supply + return piping.

b. 7.1.2

i. Piping shall be buried or covered for protection against physical damage.

1. Minimum cover depth required for underground piping systems:
    a. Minimum 12"
2. If external damage from external forces is likely to occur the minimum depth cover shall increase to:
    a. Minimum 18"
3. If the minimum cover cannot be provided, the pipe shall be installed in conduit or bridged.

c. 7.1.2.2 and 7.1.2.3

i. Trenches and backfilling

1. Terra tape
    a. A yellow tape warning diggers that gas piping is buried below. Place a few inches above the pipe. Does not provide any physical protection.
2. Dig safe shall be notified before any digging takes place
    a. 72 hours (about 3 days) in advance.

d. 7.1.3

i. Protection against corrosion

1. Instead of steel gas pipe, we will use:

a. Soft copper
b. Plastic
    i. Polyethylene

e. 7.1.5
    i. Piping which passes through a foundation wall underground shall meet the following two requirements:
        1. Encased in a protective sleeve or protected by an approved device or method.
            a. 2 pipe sizes larger: Bored hole and sleeve
            b. Relieving arch
        2. The space between the gas piping/sleeve/wall shall be sealed to prevent the entry of two things:
            a. Gas
            b. Water

f. 7.1.6
    i. Piping underground beneath buildings
        1. One end terminating indoors
        2. Both ends terminating indoors

g. 7.1.7
    i. Plastic piping
        1. Shall be installed **Outdoors Underground ONLY!**
            a. Transition using:
                i. Anodeless risers
                    1. Above ground outdoors
                ii. Wall/Service head adaptors
                    1. Above ground indoors (Basement)
        2. Tracer wire/tape shall be buried with the plastic pipe
            a. Wire gauge> 14 gauge
            b. One end shall be brought above grade the riser

2. Installation of Piping:

a. 7.2.1
    i. Piping which passes through a wall aboveground shall meet the following two requirements:
        1. The space between the gas piping/sleeve/wall shall be sealed to prevent the entry of three things:
            a. Water

b. Insects
c. Rodents

b. 7.2.2

i. Drilling, Notching, and Boring

c. 7.2.4

i. Prohibited locations
1. Clothes chute
2. Chimney or gas vent
3. Dumbwaiter
4. Elevator shaft
5. Air duct
a. Unless area above a drop ceiling is used as an air duct or for air combustion

d. 7.2.5

i. Hangers supports and anchors
1. Piping support material shall be METAL
2. Piping shall not support
piping 3. Table 7.2.5.2
4. CSST shall follow I & 0
5. Rooftop installations
a. Height requirements provided by local AHJ

3. Concealed Piping in Buildings

a. 7.3

i. Concealed piping poses a greater risk of damage from punctures than exposed piping.
ii. Fittings and prohibited connections in concealed locations:
1. Unions
a. Exception: Center Punched
2. Flares
a. Exception: Listed systems
3. Bushings
4. Compressed fittings
a. Exception: Listed systems
iii. Gas piping cannot be installed in solid partitions because it would be held rigidly in place preventing it from moving away from an object penetrating the wall.
iv. Tubing in Partitions without protection along its entire concealed length: 7.1.6.2

1. Striker plates shall extend > 4" beyond structural members
2. Tubing shall not be supported in locations not protected by striker plates
3. Tubing runs in a wall shall not be bunched together

4. Drip and Sediment Traps

a. 7.6

i. Drips are for liquid removal (condensate) while sediment traps are for debris removal.
   1. Drips
      a. Not required on LP systems and usually only required at the outlet of the meter for natural gas systems.
      b. Readily accessible and protected from freezing
      c. Shall be required in two circumstances:
         i. If required by AHJ, at the outlet of the meter
         ii. Where condensate could potentially collect

a. 7.7

   2. Sediment traps
      a. 9.6.8 and Figure 9.6.8

5. Outlets

i. Shall be securely fastened
ii. Shall not be installed behind doors
iii. Shall be installed to permit the use of a wrench. Unthreaded portion shall extend:
   1. Ceilings and walls> 1"
   2. Floors > 2"
iv. Follow I & O for all listed outlets
v. To cap all outlets requires the technician to; immediately after installation, plug all fittings or valves, and cap all pipe ends gastight.

6. Branch Pipe Connections

a. 7.8

i. A full-size tee shall be installed when the pipe size of the outlet is not known.

7. Manual Gas Shutoff Valves

a. 9.6.5

i. Appliance shutoff valves shall be within 6' of the appliance and upstream of the union.

ii. If a manifold system is used:

1. Appliance shutoff valves shall be within 50' of the appliance and upstream of union.
2. The appliance shutoff shall be readily accessible and permanently identifi ed.

b. 7.9

i. Manual gas shutoff valves for regulators are required to be installed upstream.
    1. Only 1 is required for two regulators in series
ii. Gas shutoff valves in multiple units or areas installations shall be:
    1. Readily accessible
    2. Protected from damage
    3. Permanently identified

8. Electrical Bonding and Grounding

a. 7.13

i. Non-CSST systems
    1. Shall be considered bonded when connected to an appliance with a grounded conductor
    2. Does not need to be bonded when connected to appliances with no electrically powered components.
ii. Systems with any segment of CSST shall be bonded
iii. CSST systems
    1. Listed systems: follow I & 0
    2. Bonded to the electrical service grounding electrode system
    3. Connection shall be made to any fitting or metallic pipe (not CSST) with an approved connector.
    4. Bonding jumper shall be> 6 AWG
    5. Bonding jumper shall be< 75' from gas piping connection to grounding electrode system

9. Electrical Connections

a. 7.15

i. All electrical connections shall be wired per NFPA 70
ii. All safety controls for gas shutoff shall be fail safe.

Gas Piping Inspection, Testing, and Purging Requirements Notes

1. Pressure Testing and Inspection

a. 8.1

i. General

1. All piping systems shall be visually inspected, and pressure tested to ensure compliance with NFPA 54 prior to acceptance and initial operation.

b. Pressure Tests:

i. A pressure test usually only occurs under two circumstances:

1. Prior to initial operation of piping system
2. When the piping system is altered or modified.

ii. To pressure test new piping, we must "tie in" to the existing system. This sometimes prevents permanent parts of the piping system from being included in the pressure test.

1. We are not required to pressure test these sections. We use a bubble test to determine gas tightness of the "tie in" section.

iii. A shut off valve cannot be used to separate gas in a piping section and a test medium in another.

1. The correct way to separate gas in one piping section and a test medium in another section is to install 2 valves in series with a "tell -tale" or tee located between the valves.
    a. Double block and bleed valve system.

iv. The approved test medium gasses are:

1. Air
2. Nitrogen
3. **CO2**
4. Other inert gasses
5. NEVER USE OXYGEN AS A TEST MEDIUM

v. During a pressure test pipe joints and welds shall be exposed for examination.

1. Types of Inspections
    a. Rough inspection
    b. Final inspection

c. Underground inspection

vi. Isolating Appliance from pressure test
    1. Appliances and equipment not intended to be included in the pressure test are isolated from the system by disconnecting them from the piping. Or using blind or blank flanges or caps.
    2. Appliances and equipment not designed for pressures as high as those used in the pressure test are isolated from the system by disconnecting them from the piping and capping the outlet.
    3. Appliances and equipment designed for pressures as high as those used in a pressure test are isolated by closing the appliance shut off.

vii. Test Pressure
    1. If a mechanical gauge is used with the pressure test, the maximum range on the indicator scale cannot be greater than 5x the test pressure.
        a. Ex: 3 PSI test , has max allowed is a 15 PSI gauge.
    2. The required test pressure is at least 1.5x the proposed max working pressure but not less than 3 PSI.
        a. Ex: 2 PSI operating pressure X 1 . 5 = 3 PSI

viii. Test Duration
    1. A pressure test must last a minimum of ½ hr. Per 500 cu/ft. Of volume for piping with a volume greater than 10 cubic/ft. (7320' = 10 cubic ft)
    2. A pressure test must last a minimum of 10 minutes for piping with a volume less than 10 cu/ft. in all residential installations

ix. Changes in pressure during pressure test
    1. The formula to figure out how much the pressure is allowed to change due to a change in temperature is in annex B.7.5
        a. Commercial
    2. If the pressure rises in a gas piping system, then the system is likely gas tight
    3. If the pressure drops, and isn't attributed to a change in temperature, we must locate the leak.
        a. When we find a leak , we are required to fix it and re-test.

2. Piping System Leak Check:

a. 8.2

i. When turning the gas on we must inspect the gas piping system to ensure all fittings, outlets, and valves are plugged or capped.

ii. If the pressure test indicates a leak, the leak should be located using:

1. Approved gas detector (electronic)
2. Non-corrosive leak detector solutions (No ammonia)
3. Other approved methods-3 min leak check
4. NEVER USE A SOURCE OF IGNITION-A LIGHTER

b. 5 reasons why a leak check should be performed:

1. Every time gas is turned on!
    a. New or modified piping is placed into service
2. Gas leak is suspected
3. Gas meter is replaced
4. Appliance or appliance connector is replaced
5. Out of gas condition

c. The difference between when a pressure test and a leak test should be performed:

i. A pressure test is needed for new piping while a leak check is required every time the gas is turned on.

ii. Appliances should be isolated from the piping while performing a leak check because some manufacturers allow for small gas leak which will not accumulate flammable amounts of gas (below L.E.L, lower explosive limit)

d. Leak check pressure, duration and medium

i. The test medium is fuel gas and ASP (Available supply pressure) pressure is used for a leak check. The pressure must hold for 3 minutes.

e. How to perform a leak check using a manometer

i. Install a manometer to the system; pressurize the system momentarily and then shut off the gas. No change in pressure should occur in 3 minutes. A leak which would cause an unsafe accumulation of gas would be evident within 3 minutes of this leak check.

3. Purging Requirements:

a. 8.3

b. Piping systems required to be purged outdoors

i. >2psi or piping system meets the requirements of Table 8.3.1
ii. Removal from service
    1. Residual fuel gas in existing piping to be removed shall be displaced with an inert gas (Nitrogen) to the outdoors.
iii. Placing into operation.
    1. Air in gas piping to be placed into operation shall be displaced with an inert gas to the outdoors.
iv. Purging operations shall comply with all 5 requirements of NFPA 54: 8.3.1.3
v. Combustible gas indicators vs combustible gas detectors
    1. Combustible gas indicators will indicate fuel gas levels as a% by volume
        a. Required for purging to the outdoors, can be used for purging to the indoors as well.
    2. Combustible gas detectors simply indicate the pressure of fuel gas.
        a. Required for purging to the indoors, cannot be used for purging to the outdoors.

c. Piping systems allowed to be purged indoors or outdoors:
    1. Less than 2 psi
    2. Piping system NOT meeting the requirements of Table 8.3.1
ii. Purging operations shall comply with 1 or more of the 5 requirements of NFPA 54: 8.3.2.1
    1. Example of written procedures
        a. Do not purge into a confined space to where a source of ignition is present unless precautions are taken to:
            i. Ventilate the space
            ii. Control the purge rate
            iii. Eliminate all hazardous conditions

d. Purging Appliances and equipment
i. After the piping has been purged, appliances and equipment shall be purged before placing into operation.

Pulling a Permit.

Home rule or local rule – Unlike other states in which all municipalities follow the exact same code requirements, NH has what's called Home rule. This allows local municipalities (cities and towns) to make amendments to the state adopted code requirements. They can be more stringent than the code. The catch is that if amendments exist, they **must** be available to the installing contractor when they go to obtain the permit from the AHJ at the municipal building (town hall, city hall, fire department, etc.)

Always be sure to ask for town/city specific amendments or requirements **before** beginning the process.

Ex: Some municipalities do not allow CSST (corrugated Stainless Steel Tubing).

Best-case Scenario:

> You call the AHJ and find out that they do not allow CSST. You also inquire about the exact permit fee and inspection requirements.

Results:

1. You do not bid the job using CSST.
2. You do not need to estimate the permit fee, you know the exact amount to add to the bid.
3. You know their requirements for inspection.
    a. Some towns require a standing inspection. Meaning someone from the installing company needs to be present on any and all inspections. This is sometimes even required to be the installing technician. If so, you can now add this expense into your bid.
4. Your company provides a high level of service while turning a profit.

Explaining these requirements to the homeowner will be necessary for the salesman to do. Most likely, other companies have not done their homework and will not incorporate all the necessary expenses to meet local AHJ requirements. This is a prime opportunity for your company to set themselves apart from the competition and demonstrate the added value they get from using a professional establishment like your company even though you are the highest bid. Remember you get what you pay for, there's no such thing as a free lunch!

OK Case Scenario:

You do not call the local AHJ to find out any specific requirement before bidding the job. You get the job and go pull the permit before you begin.

Results:

1. At this time you realize your mistakes and clarify with the homeowner before starting the job. You increase your original quote to reflect the necessary changes.

2. They are upset but still decide to go with you since you came highly recommended. However, you have not instilled confidence in your abilities to the customer.

3. You turn a profit and learn a valuable lesson.

Worst Case Scenario:

You do not call the local AHJ to find out any specific requirement before bidding the job. You also begin the installation before you pull the permit and obtain the additional local amendments/requirements.

Results:

1. You get the job and complete the install. At this time you go to the AHJ to pull a permit and schedule an inspection date.

2. Now you realize your mistakes and must re-pipe the entire job in a different approved piping material.

3. You finish the job and give the customer a bill for 10% more than the original estimate because in NH you are legally allowed to come in + or – 10% of a bid and they customer must pay it. It no where near even covers the cost of the changes.

4. They are upset but pay you the increase.

5. They become a cheerleader for your company, but not in a good way. A satisfied customer may tell 1 person about you and your company. An upset customer will definitely tell at least 4 people about how bad you are.

6. You net a loss on the job, do not gain a customer, and learn an expensive lesson.

Almost Absolute Worst Case Scenario:

You do not pull a permit for the job.

Results:

1. You install CSST.
2. You turn a profit on the job.
3. The customer, who obviously chooses based on price has no loyalty to you and decides to add a gas insert and calls around to get the best price (cheapest contractor they can find) to do the job.
4. They find a company from the best-case example who explains that their entire gas piping system does not meet code and must be brought up to local standards before anyone can proceed.
5. Now the upset customer, local AHJ, State Fire Marshal, Lawyers and others want to talk to you.
6. But no one died so it's not the absolute worst-case scenario. Focusing on that good news will help you through what's to come!

Not only is it required to pull a permit to meet code and local requirements; it is also necessary for manufacturers to warranty their equipment. By not pulling a permit if anything goes wrong you are guilty until proven innocent. Even a manufacturers defect could be your fault.

The inspections that will usually occur depend on the scope of work.

Appliance replacement (Boiler/ water heater swap).

With this scope of work the inspector usually won't require a pressure test on the branch piping that you altered to accommodate the new appliance. He will want to inspect the piping and see it leak tested with a non-corrosive leak-detecting fluid (bubble test).

The Inspector will be ensuring the appliance is installed per manufacturers I and O manual, the codebook and any amendments/regulations from their home rule.

Adding a branch to an existing gas piping system

With this scope of work the inspector is going to want to see the piping isolated from the existing piping and a pressure test performed on the new piping. We will learn about these requirements later.

The Inspector will be ensuring the appliance is installed per manufacturers I and O manual, the codebook and any amendments/regulations from their home rule.

Both of the above will usually be done at the same time.

New gas piping in an existing building.

With this scope of work the inspector will want all piping accessible and exposed for inspection. A pressure test will be required on the entire GPI. We will learn about the requirements for this later.

The Inspector will be ensuring the appliance is installed per manufacturers I and O manual, the codebook and any amendments/regulations from their home rule.

Both of the above will usually be done at the same time.

New gas piping in a new building.

With this scope of work the inspector will want all piping accessible and exposed for rough inspection. This is done before the sheetrock covers any piping. A pressure test will also be required on the entire GPI. We will learn about the requirements for this later.

The Inspector will be ensuring the appliance is installed per manufacturers I and O manual, the codebook and any amendments/regulations from their home rule. This will be done at the final inspection.

Principles & Properties of Fuel Gases

Heat: Is a form of energy that results in the motion of atoms.

Temperature: Is a measure of the intensity or heat level of a substance.

- Absolute zero is the temperature at which molecular motion stops. It is the lowest temperature possible. There is no heat in the substance at this point. (-460*F)
- British thermal unit (BTU)
- The BTU is the amount of heat required to raise the temperature of a pound of water one degree Fahrenheit.
- A Birthday candle = 1 BTU

Hydrocarbons:

- Hydrogen and carbon (All heat comes from) atoms make up a hydrocarbon molecule.
- Wood is a solid hydrocarbon; coal is as well.
- #2 heating oil is a liquid hydrocarbon.

140,000/BTUs per gallon, 85%C and 15%H: or 140 MBH (Roman Numeral, BTU, Heat)

- Both natural and LP gasses are vapor hydrocarbons.

Propane: Blend mainly propane (c3h8) sometimes butane (c4h10) is added sold in gallons and can be measured in cu FT.

LP= Liquefied petroleum.

Natural Gas: Blend 95% (methane ch4) 5% (ethane c2h6) butane added in winter to increase heat content.

Sold and measured in cu ft. Cubic ft.

- The amount of gas that would occupy 1 cubic ft. When at a temperature of 60*F, saturated with water vapor and under a pressure equivalent to that of a 30" WC.
- The more carbon content the more heat content and the closer to a solid state.
- The more hydrogen a molecule contains, it is closer to vapor and lower the heat content.

Both natural and LP gas are in the vapor state at the point of delivery when NFPA 54 applies. This course is based on NFPA 54; therefore, most discussions will pertain to natural and LP in the vapor form.

Volume: is the physical space that a substance occupies.

- In most cases, solids and liquids are practically non-compressible.
- Gasses do not have a fixed volume; they expand to fill whatever container they are in.
- Once gas completely fills a container, any additional gas added will increase the pressure and temperature. This is due to energy added by compression.
- A fluid is any substance whose molecules move freely past each other, meaning both liquids and gasses are fluid.

Pressure: is a force per unit of area.

- A gas expands to completely fill its container and exerts pressure on all surfaces of the container.
- It is most expressed in PSI (Pounds per square inch)

Measuring Pressure:

- Atmospheric pressure: About 14.0 PSIa at sea level. PSIA= PSI absolute= Gauge pressure + 14.0 PSIa
- Two most common units of measurement for pressure of gas systems. PSI and "WC (water column)

Gauge Pressure:

- Register in pounds per square inch above atmospheric pressure (PSIG or PSI)
- A reading of O PSI on the gauge pressure scales is equal to atmospheric pressure.
- Pressure above atmospheric pressure registers on the gauge.

Water Columns:

- Usually designed for measuring small pressures above or below atmospheric pressure.
- These pressure measuring devices are called manometers. Three types: U-tube, Spring gauge, and Digital.
- They are calibrated in inches of water column. A water column 2.3' high (or about 28") equals 1 PSI. 1 PSI = 28 "WC.
- Relationship of pressure, volume and temperature.
- If a gas's temperature increases, its pressure or volume must increase proportionally. If a gas's temperature decreases, its pressure or volume must also decrease.

Typical gas pressures found in the Field: Refer to Exhibit 1.1 (pg.6 NFPA 54)

Natural Gas:

- Supply pressures from the serving gas supplier (SGS) found in the service line (Gas main) before the service regulator and meter: 8" W.C.-60 PSI
- System pressures after the gas suppliers service regulator and meter in the system piping to the appliance regulator or to the appliance gas valve (which has a built-in regulator): 3.5" W.C - 8" W.C
- (Normal system pressures found inside the building after the service regulator are typically between 3.5" W.C - 5" W.C. Most applications want a minimum of 5" W.C going to the gas valve for proper operation and manifold pressure.)

Common Manifold Pressure: 3.5" W.C.

LP:

Storage Tank pressures: Max of 312 psi, usually 20-80 psi.

- Relief valves on LP storage tanks vents vapors when pressure reaches 312 psi.

1st stage regulator pressure:

- Inlet: Tank Pressure
- Outlet: 10 lbs.
- This pressure is found in the piping which runs from 1st stage regulator at the storage tank to the 2nd stage regulator located at the point of entry at the building.

2nd stage regulator pressure:

- Inlet: 10 lbs.
- Outlet: 11-14"W.C.
- (Normal system pressures found inside the building after the 2nd stage regulator are typically between 11-14" W.C. Most appliances want a minimum of 11" W.C going to the gas valve for proper operation and manifold pressure.)

Common manifold pressure: 10" W.C. for L.P.

As always, the above pressures are guidelines for typical installations. Always contact the serving gas supplier to verify supply pressures available from their piping and regulators to the system piping.

Manufacturers Installation and operations(I&O) manuals must be referenced for required inlet pressures to the appliance gas valve and proper setup for manifold pressures.

Classifications:

Oxidizers: Oxidizers are not flammable by themselves, but will contribute to combustion as an oxidant. Fat or oil is not acceptable in combination with oxidizers.

Some common oxidizers:

- Air - 78% Nitrogen / 21% Oxygen / 1% Trace gases
- Chlorine
- Fluorine
- Nitric Oxide
- Nitrogen Dioxide
- Oxygen

Inert Gases:

Inert gases do not take part in combustion processes, and they do not react with other materials. An inert gas supplied to a room or limited space will reduce the amount of oxygen and limit the combustion process of a fire. Inert gasses are used in extinguishing systems where it is important to avoid water damage - rooms with electronic devices, etc.

Some inert gases:

- Argon
- Carbon Dioxide
- Helium
- Neon
- Nitrogen
- Xenon

Flammable

gasses:

Flammable gases together with air or oxygen in the right concentration burns or explodes if ignited.

If the mixture is too lean or too rich the mixture will not ignite. Some

Flammable gases:

- Acetylene
- Ammonia
- Arsine
- Butane
- Carbon Monoxide
- Cyclopropane
- Ethane and Methane: natural gas is a mixture of these.
- Ethylene
- Ethyl Chloride
- Hydrogen

- isobutane
- Methyl Chloride
- Propane
- Propylene
- Silane

Fuel Gases:

Fuel gasses are hydrocarbons.

Fuel gases are colorless, odorless and tasteless. Fuel gases are purposefully odorized to allow a warning than an otherwise odorless gas is escaping.

Properties of gases:

It is important to realize that both Natural gas and L.P gas properties can be a range because both gases are always a blend.

Ignition Temperatures:

A concentration of heat is needed to start the chemical process of combustion. The heat required to initiate combustion is typically provided by a pilot light or heated surface.
HSI= Hot Surface ignitor.

- Natural gas: Between 1100- and 1200-degrees F
- L.P: Between 920- and 1020-degrees F

Flammability limits:

The range of fuel concentrations within which the fuel will burn when an ignition source is present.

A Concentration of gas less than its L.E.L(Lower explosive Limit) is too lean, meaning there is not enough fuel for combustion.

A concentration of gas greater than its U.E.L(Upper explosive Limit) creates a mixture that is too rich, meaning there is not enough oxygen available for all the fuel present.

- Natural Gas: Lower Flammability Limit: 3.9% Upper: 14%
- L.P. Gas: Lower Flammability Limit: 2.4% Upper: 9.6%

Oxygen/Source:

Our oxygen source is air: 21% oxygen, Nitrogen, 1% trace gases.

Excess Air:

Excess air is any secondary air that exceeds the amount of air necessary for complete combustion. Needed to prevent the possibility of incomplete combustion.

Natural Gas:

- Ideal oxygen to natural gas ratio is 2:1
- Ideal air to natural gas ratio is 10:1
- Actual air to natural gas ratio is between 11-15:1

Propane:

- Ideal oxygen to propane ratio is 5:1
- Ideal air to propane ratio is 24:1
- Actual air to propane ratio is between 27-35:1

Specific Gravity:

As applied to gas, the ratio of the weight of a given volume to that of the same volume of air, both measured under the same conditions.

The specific gravity of air at standard conditions (68 F and 14.?psia) is 1.

A gas with a specific gravity greater than 1 will settle in low areas and accumulate. While a gas with a specific gravity less than 1 will rise and dissipate.

Specific Gravities for natural and LP gases:

- Air: 1
- Natural Gas: .65
- Propane: 1.52

Heating Value:

The number of BTU's produced by the combustion of 1 cubic ft of gas when all the necessary corrections have been applied.

- Natural Gas (sold in cubic feet): 1000 BTUs per cubic foot.
- L.P Gas (Sold per gallon): 2500 BTUs per cubic foot.

Key Abbreviations:

AHJ: Authority having Jurisdiction SGS:

Serving Gas Supplier

I&0: Installation and operation manual

POD: Point of Delivery

ASP: Available supply pressure

"WC: inches of water column.