Canadian Gas Technician - Learning Module 18

Propane Systems and Installations

Learning Objectives

Upon completion of this chapter, students will be able to:

01

Design propane systems

Design single-stage and two-stage propane systems for various applications

02

Select and size tanks

Select and size propane tanks and cylinders according to CSA B149.2 requirements

03

Install regulators

Install and configure propane regulators for proper pressure reduction

04

Size piping systems

Size and install propane piping systems with appropriate correction factors

05

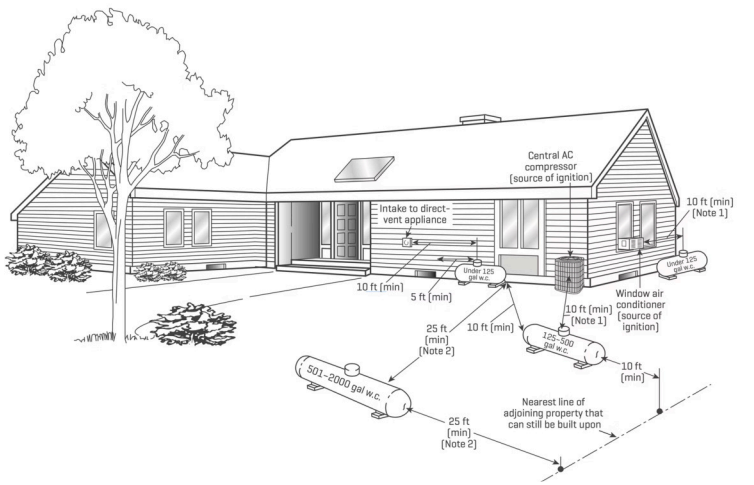
Convert appliances

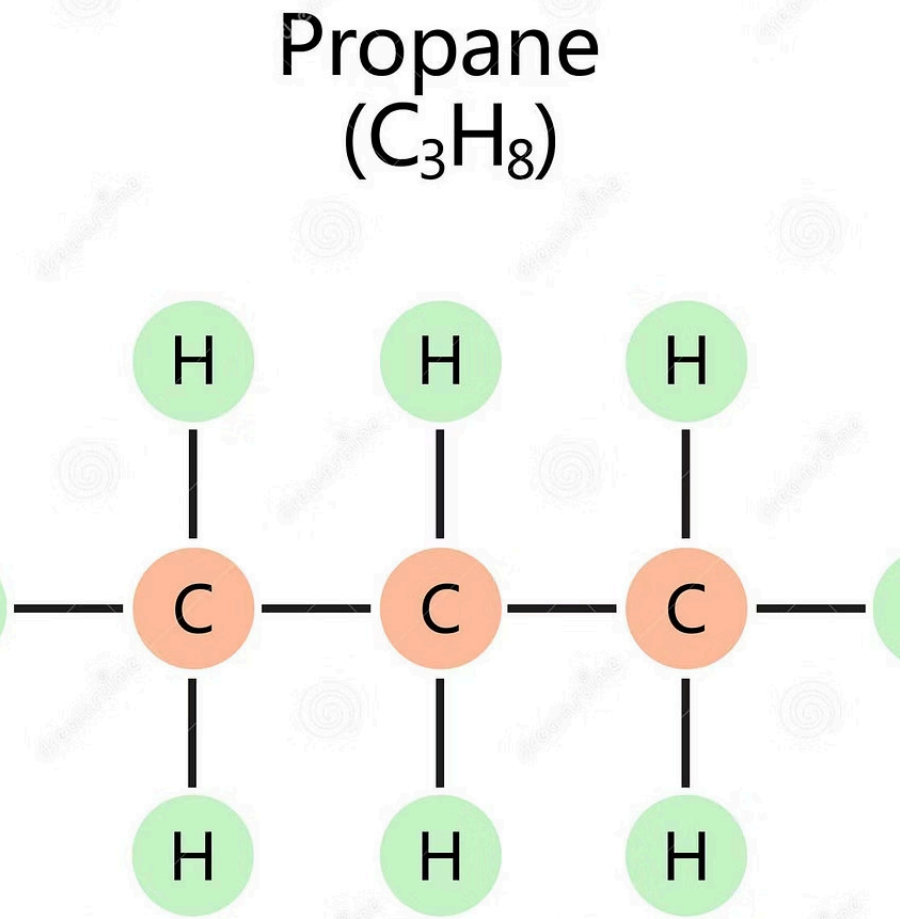
Convert natural gas appliances to propane following manufacturer specifications

18.1 Propane System Design

Propane systems require careful design to ensure adequate supply, proper pressure, and safe operation under all conditions. Understanding propane properties is essential for proper system design.

The design process involves analyzing load requirements, selecting appropriate components, and ensuring compliance with CSA B149.2 standards. System fundamentals include understanding physical characteristics, vaporization behavior, and safety properties of propane gas.





Propane Properties

Physical Characteristics

- Chemical formula: C_3H_8
- Molecular weight: 44.1
- Specific gravity (gas): 1.52
- Specific gravity (liquid): 0.504
- Boiling point: -44°F (-42°C)
- Vapor pressure at 70°F: 127 psig
- Expansion ratio: 270:1

Energy Content

- BTU per gallon: 91,547
- BTU per pound: 21,548
- BTU per cubic foot: 2,516
- Latent heat: 184 BTU/lb
- Temperature drop during vaporization
- Frost formation on tanks

Safety Properties

- Flammability: 2.15% - 9.6%
- Ignition temp: 920°F - 1,020°F
- Heavier than air
- Odorant added (ethyl mercaptan)
- Non-toxic but asphyxiant

Safety Properties

Flammability Limits

Propane has flammability limits between 2.15% and 9.6% in air. This narrow range means proper ventilation is critical to prevent dangerous concentrations.

Ignition Temperature

Ignition occurs between 920°F and 1,020°F. While relatively high, all ignition sources must be eliminated in areas where propane may be present.

Heavier Than Air

With a specific gravity of 1.52, propane is heavier than air and pools in low areas. This creates particular hazards in basements, pits, and confined spaces.

Single-Stage vs. Two-Stage Systems

System configuration depends on application requirements and local codes. Understanding the differences between single-stage and two-stage systems is crucial for proper design.

Single-Stage Systems

Single-stage systems use one regulator to reduce tank pressure directly to appliance pressure (11" W.C.). These systems are simpler but have limitations in capacity and pressure stability.

Two-Stage Systems

Two-stage systems use two regulators: first stage reduces tank pressure to 10 psi, second stage reduces to 11" W.C. This provides better pressure control and higher capacity.

Single-Stage Systems

Applications

- Small residential systems
- Single appliance installations
- Cylinders under 420 lbs
- Short piping runs
- Moderate flow requirements

Components

- Tank or cylinder
- Single regulator (tank to 11" W.C.)
- Piping system
- Appliance connections
- Safety devices

Advantages

- Simple installation
- Lower initial cost
- Fewer components
- Easier troubleshooting
- Minimal maintenance

Single-Stage System Characteristics

Disadvantages

- Pressure variation with temperature
- Limited capacity
- Shorter regulator life
- Less precise pressure control
- Not suitable for large loads

Pressure Characteristics

- Inlet: Tank pressure (varies)
- Outlet: 11" W.C. nominal
- Variation: ±2" W.C. typical
- Lock-up pressure: 14" W.C. maximum
- Temperature effect: Significant

Gauge Reading	29Gal	57Gal	120Gal	320Gal	500Gal	1000Gal
80%	23	46	96	256	400	800
70%	20	40	84	224	350	700
60%	17	34	72	192	300	600
50%	14	28	60	160	250	500
40%	11	22	48	128	200	400
30%	9	17	36	96	150	300
20%	6	11	24	64	100	200
10%	3	5	12	32	50	100

Two-Stage Systems

Tank Storage

Propane stored at vapor pressure (varies with temperature)

First Stage

Reduces tank pressure to 10 psi intermediate pressure

Second Stage

Reduces 10 psi to 11" W.C. for appliances

Appliances

Receive consistent 11" W.C. supply pressure

Applications: Large residential systems, commercial installations, multiple appliances, long piping runs, and critical pressure requirements all benefit from two-stage regulation.

Components: Tank or multiple tanks, first-stage regulator (tank to 10 psi), second-stage regulator (10 psi to 11" W.C.), high and low pressure piping systems, multiple appliances, and comprehensive safety and monitoring devices.

Two-Stage System Characteristics

Disadvantages

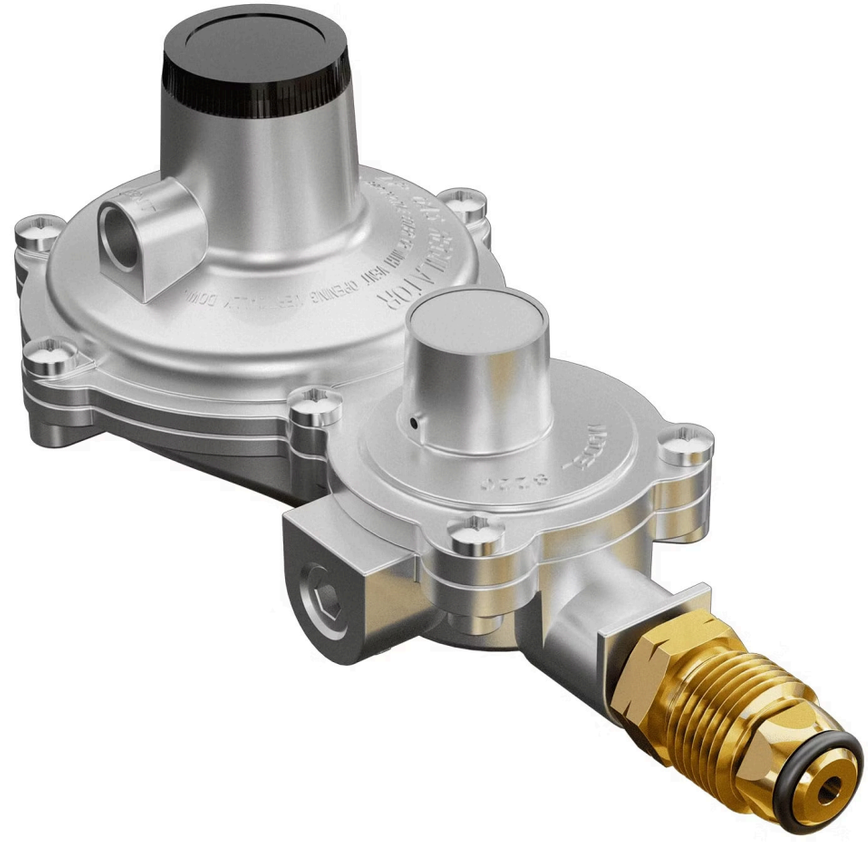
- Higher initial cost
- More complex installation
- Additional components
- More potential failure points
- Requires higher skill level

Pressure Characteristics

- First stage inlet: Tank pressure
- First stage outlet: 10 psi typical
- Second stage inlet: 10 psi
- Second stage outlet: 11" W.C.
- Variation: ±1" W.C. typical

Design Considerations

- Distance between stages
- Pipe sizing between stages
- Regulator sizing
- Relief valve placement
- System monitoring



Vapor Withdrawal Systems

Most common propane system type for residential and light commercial use. Vapor withdrawal systems rely on natural vaporization of liquid propane within the tank.

Vaporization Capacity

Tank vaporization depends on multiple critical factors:

Tank Size

Wetted surface area determines vaporization rate

Liquid Level

Percentage full affects available surface area

Temperature

Ambient temperature dramatically affects vaporization

Withdrawal Rate

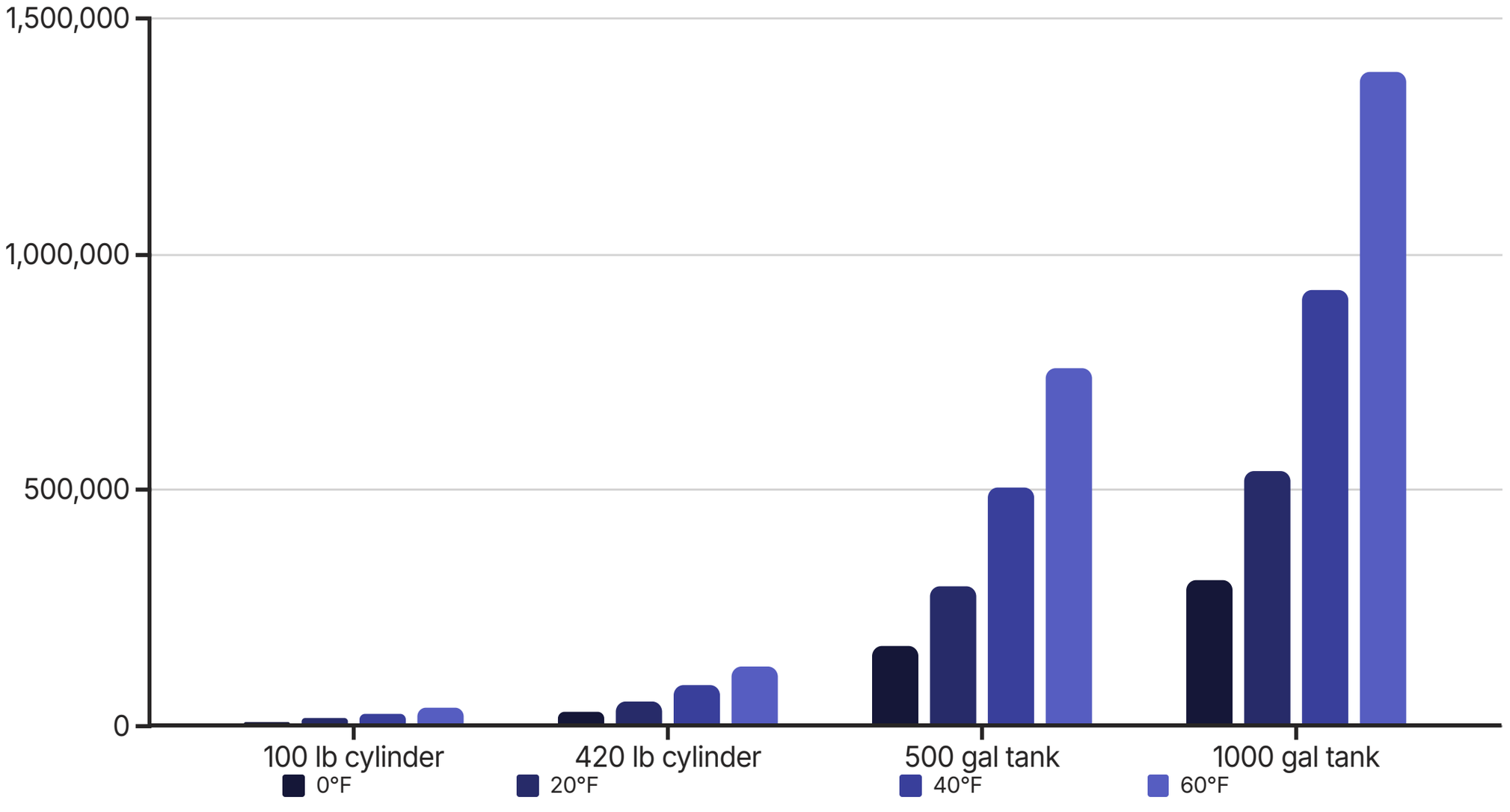
Continuous vs. intermittent demand patterns

Tank Design

Above-ground vs. below-ground installation

Vaporization Rates

Continuous vaporization rates at 50% full (BTU/hr):



Temperature Effects: Pressure drops with temperature, vaporization reduces tank temperature, frost indicates high withdrawal rate, ambient temperature is critical, and tank heating is sometimes required for adequate vaporization.

Vapor System Components

01

Storage Tank/Cylinder

Properly sized for load, located for vaporization, protected from damage, accessible for filling, and relief valve equipped

02

Vapor Service Valve

Located in vapor space with excess flow protection, back-check capability, service shutoff, and pressure gauge connection

03

Regulators

Sized for maximum flow with proper inlet/outlet ratings, vent protection, relief valve provisions, and suitable lock-up pressure

04

Piping System

Sized for flow and distance, protected from damage, proper materials, expansion provisions, and testing capabilities

Design Calculation Example

System Requirements

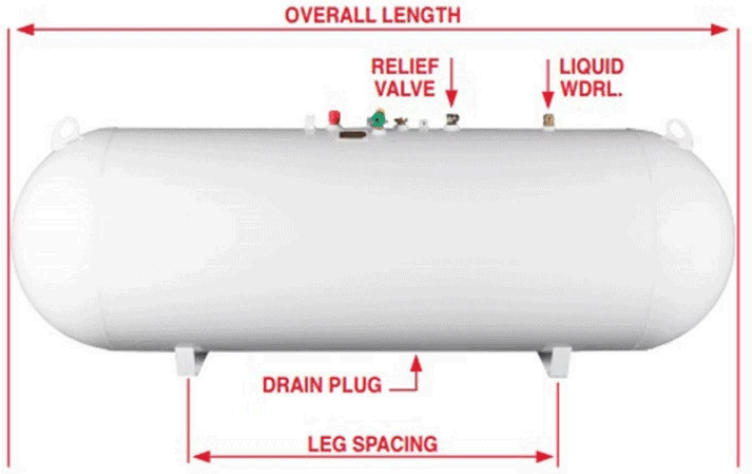
- Total load: 250,000 BTU/hr
- Design temperature: 0°F
- Distance to appliances: 150 feet

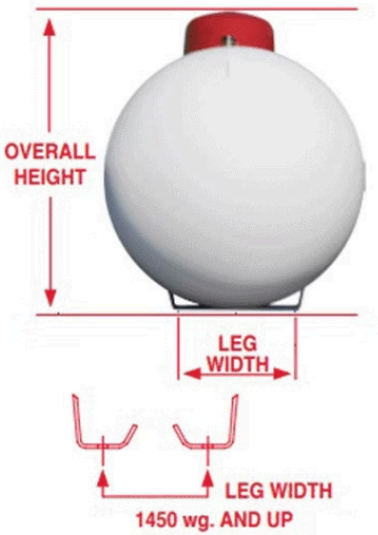
Tank Sizing

Required vaporization: 250,000 BTU/hr

500 gal tank at 0°F provides only 168,000 BTU/hr - insufficient for the load.

Solution: Select 1000 gal tank (308,000 BTU/hr at 0°F) or use multiple smaller tanks manifolded together.





APPROXIMATE ABOVEGROUND VESSEL DIMENSIONS AND SPECIFICATIONS

WATER CAPACITY	DIAMETER (OD)	HEAD TYPE	OVERALL LENGTH	OVERALL HEIGHT	LEG** WIDTH	LEG** SPACING	WEIGHT (lbs.)	***QUANTITY	
								FULL LOAD	PER STACK
*120 wg.	24"	Ellip.	5'-8"	2'-10"	1'-1 1/2"	2'-10 1/2" or 3'-11"	260	108 | 112	16 | 14
*250 wg.	30"	Hemi.	7'-10"	3'-6"	1'-5"	4'-11"	480	54	9
*320 wg.	30"	Hemi.	9'-7"	3'-6"	1'-5"	5'	620	45	9
500 wg.	37 1/2"	Hemi.	10'	4'	1'-8"	5'	950	37 | 30	8 | 6
1000 wg.	41"	Hemi.	16'	4'-3"	1'-8"	10'-1"	1,800	15	5
1450 wg.	46 1/2"	Ellip.	17'-4"	4'-9"	1'-9"	11'-7"	2,650	12	4
1990 wg.	46 1/2"	Ellip.	23'-11"	4'-9"	1'-9"	16'	3,520	8	4

Dimensions and specifications shown are approximate. Individual vessels may vary.

Liquid Withdrawal Systems

Used for high-capacity commercial and industrial applications where vapor withdrawal cannot meet demand.

1	**Liquid Withdrawal Valve** Dip tube to tank bottom, excess flow valve, manual shutoff, hydrostatic relief, and back-check valve
2	**Vaporizer** Sized for maximum flow with heat source (electric/steam/water), temperature controls, safety shut-offs, and pressure relief
3	**High-Pressure Piping** Schedule 80 steel, pressure rated fittings, hydrostatic relief valves, proper supports, and insulation if required

When Required: Vaporization exceeds tank capacity, consistent high flow rates, cold climate operations, process applications, and fork truck filling operations.

Vaporizer Types

Direct-Fired Vaporizers

Propane-fired heat source using 1-2% of vaporized gas. Automatic operation with capacity from 100,000 to 10,000,000 BTU/hr. Stand-alone operation without external utilities.

Electric Vaporizers

Immersion heaters provide precise temperature control with no combustion products. Capacity from 50,000 to 500,000 BTU/hr but with higher operating costs.

Steam/Hot Water Vaporizers

Uses available steam or hot water in shell and tube design. No additional fuel cost with capacity from 100,000 to 5,000,000 BTU/hr. Requires utility source.

Ambient Air Vaporizers

No external heat source, limited by ambient temperature. Fins for heat transfer with capacity from 50,000 to 250,000 BTU/hr. Supplemental heat often needed.

Vaporizer Safety Requirements

Pressure Protection

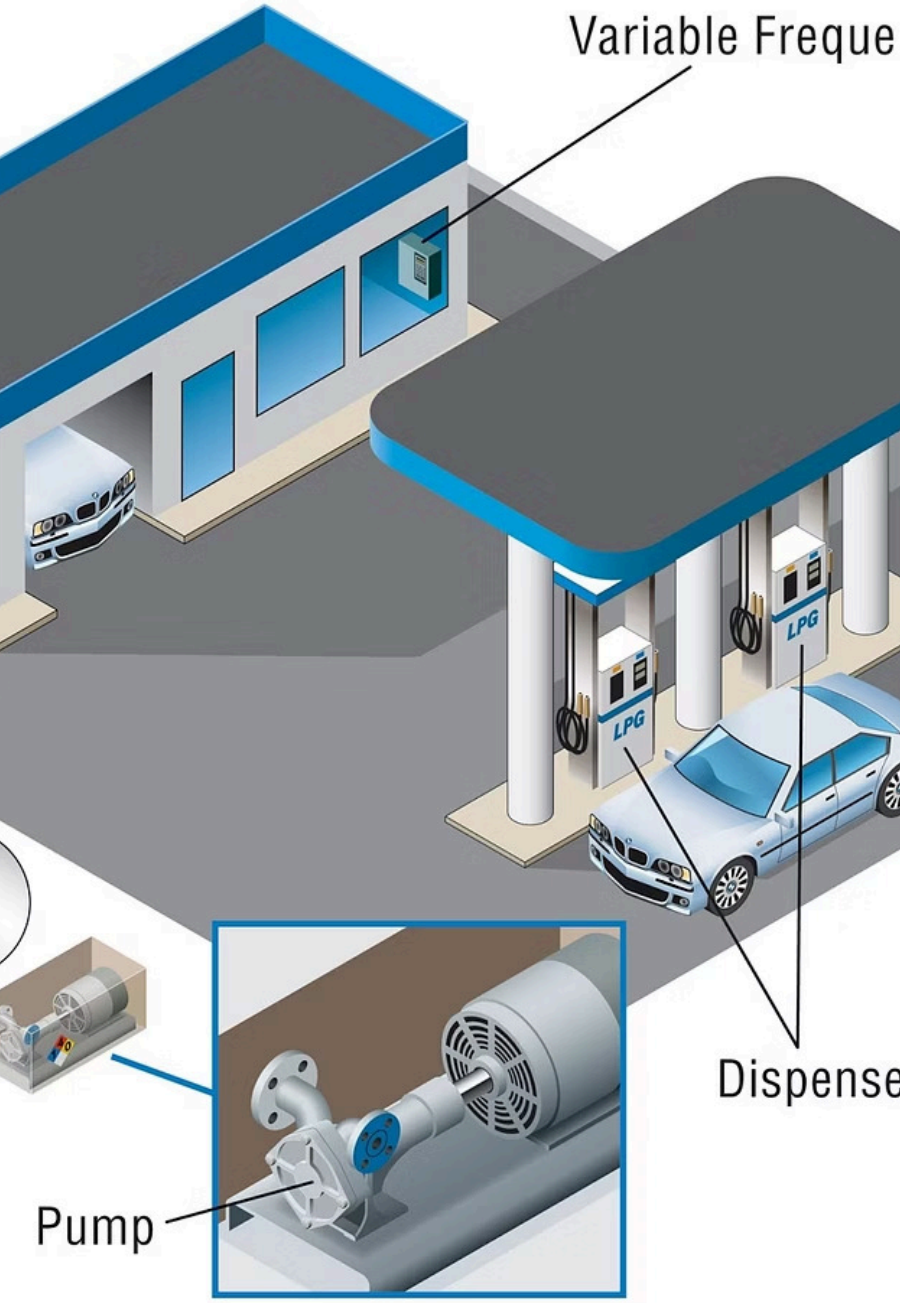
Pressure relief valves and excess flow protection with emergency shutdown capabilities

Temperature Controls

High-temperature shut-off, low-temperature alarm, and precise temperature monitoring

Ventilation

Adequate ventilation requirements and proper electrical classification for hazardous locations



System Component Selection

Proper component selection ensures reliable and safe operation throughout the system's lifetime.

Capacity Requirements

- Peak hourly demand
- Continuous demand
- Future expansion
- Vaporization capacity
- Storage capacity
- Delivery frequency

Installation Factors

- Available space
- Access for delivery
- Setback requirements
- Above/below ground
- Local code restrictions
- Aesthetic concerns

Cost Considerations

- Initial tank cost
- Installation cost
- Rental vs. purchase
- Delivery charges
- Maintenance costs
- Insurance requirements

Regulator Selection

Sizing Factors

Maximum flow rate, inlet pressure range, outlet pressure required, allowable pressure drop, temperature range, and accuracy requirements all influence regulator selection.

Application	First Stage	Second Stage
Residential	10-15 psi	11" W.C.
Commercial	10-20 psi	11-14" W.C.
Industrial	5-125 psi	Various
Fork trucks	Liquid to vapor	Varies

Features to Consider

Internal relief valve, vent limiting device, integral two-stage design, automatic changeover capability, OPSO (over-pressure shut-off), and UL/CSA listing ensure safe and reliable operation.

Piping Component Selection

Material Options

- Steel pipe (Schedule 40)
- Copper tubing (Type K or L)
- CSST (Corrugated Stainless Steel Tubing)
- Polyethylene (underground only)
- Stainless steel

Fitting Selection

- Malleable iron (indoor)
- Forged steel (high pressure)
- Brass (certain applications)
- Flare fittings (copper)
- Compression fittings (limited use)

Valve Selection

- Ball valves (full port)
- Appliance connectors
- Service valves
- Emergency shutoffs
- Excess flow valves

Pressure Requirements at Appliances

Residential Appliances

- Design pressure: 11" W.C.
- Minimum: 10" W.C.
- Maximum: 13" W.C.
- Measured at appliance inlet
- Full flow conditions

Commercial Equipment

- Standard: 11" W.C.
- Some equipment: 14" W.C.
- Others: 2 psi or higher
- Manufacturer specifications
- Dedicated regulators possible

Maintaining proper pressure ensures safe and efficient operation of all connected appliances. Pressure must be verified under full flow conditions with all appliances operating simultaneously.

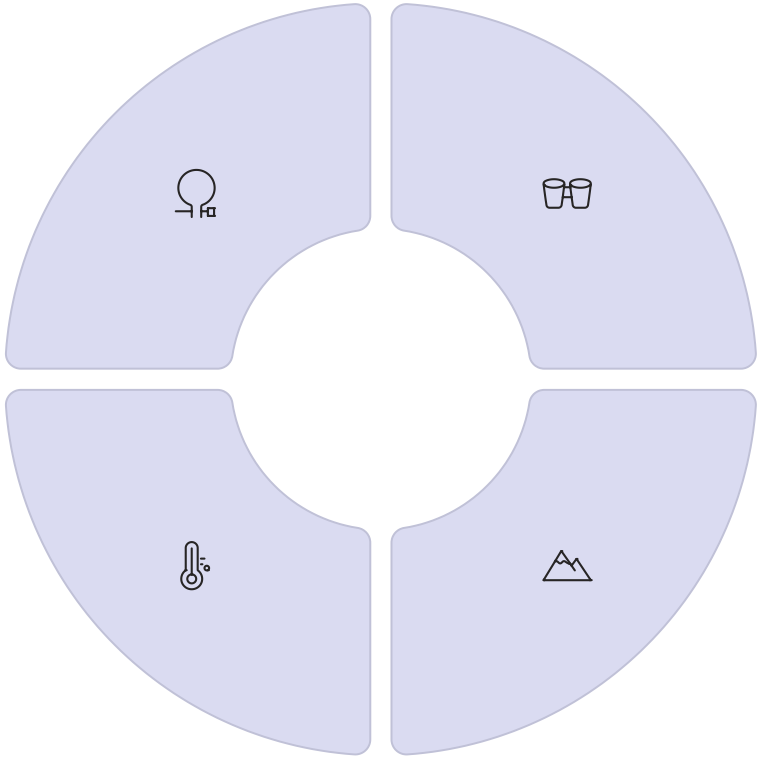
Pressure Drop Calculations

Allowable Pressure Drop

Residential systems: 0.5" W.C. maximum | Commercial systems: 1" W.C. typical | Industrial: Per design | High pressure: 10% of initial | Between stages: 10% maximum

Pipe Friction

Length of run, pipe diameter, flow rate, specific gravity, and pipe roughness



Fitting Losses

Equivalent lengths, valve restrictions, direction changes, diameter changes, and connection types

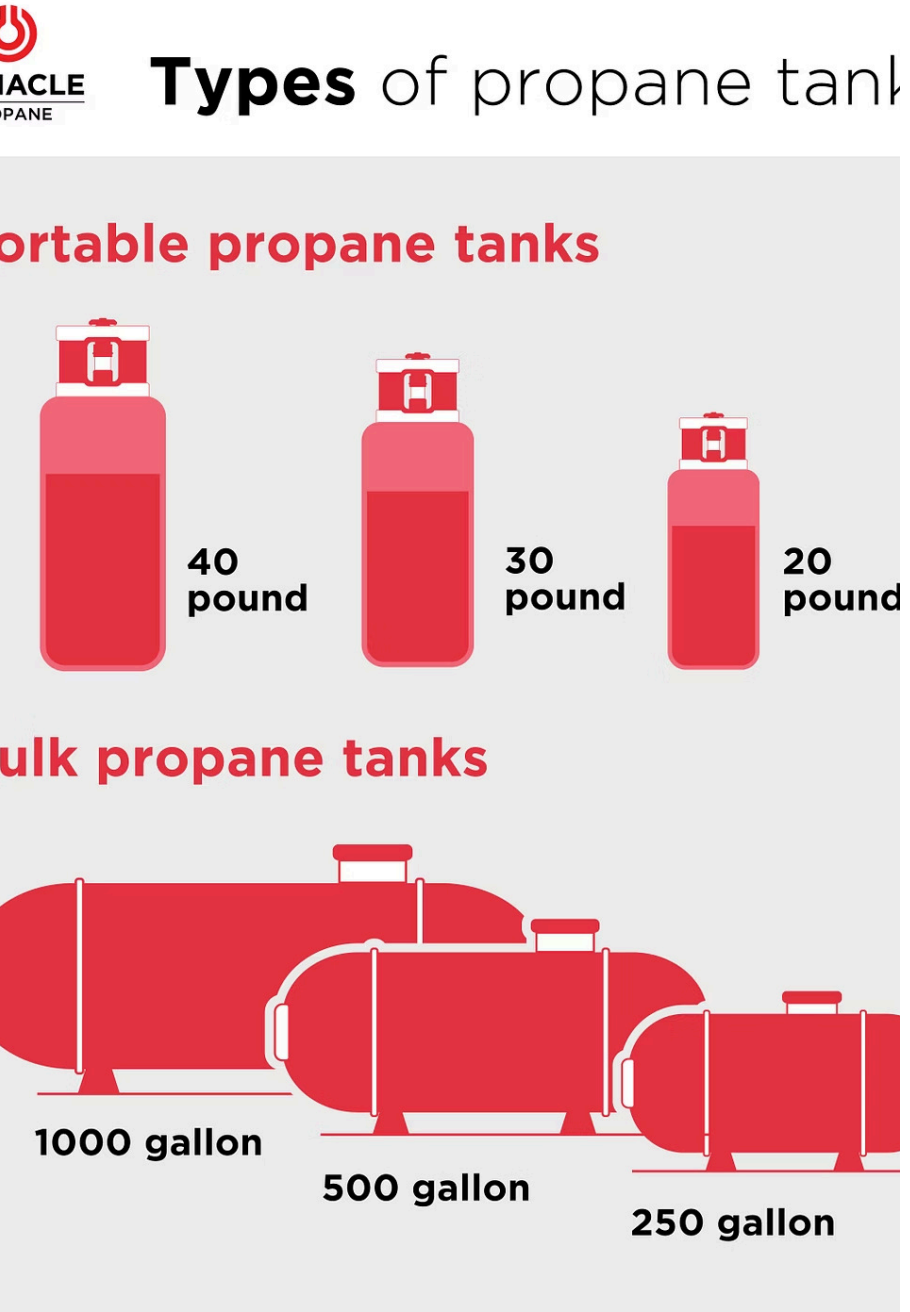
Temperature Effects

Gas density changes, regulator performance, tank pressure variation, vaporization rates, and material expansion

Elevation Changes

0.5" W.C. per 100 ft rise affects low pressure systems, negligible in high pressure

Verification Methods: Manometer testing, digital pressure gauges, chart recorders, data loggers, and remote monitoring ensure proper system performance. Testing must be conducted with all appliances operating under maximum flow conditions.



18.2 Propane Tanks and Cylinders

Proper tank and cylinder selection, installation, and maintenance ensure safe propane storage. Understanding DOT/TC specifications, ASME tank requirements, and proper sizing methods is essential for code-compliant installations.

DOT/TC Cylinder Specifications

Cylinders are manufactured and certified to Department of Transportation (DOT) or Transport Canada (TC) specifications.

Size	Water Capacity	Propane Capacity	Dimensions	Weight (Empty)
20 lb	47.6 lbs	20 lbs	18"H × 12"D	18 lbs
30 lb	71.4 lbs	30 lbs	24"H × 12"D	25 lbs
40 lb	95.2 lbs	40 lbs	29"H × 12"D	29 lbs
100 lb	238 lbs	100 lbs	48"H × 15"D	67 lbs
420 lb (100 gal)	1000 lbs	420 lbs	53"H × 30"D	209 lbs

Cylinder Specifications: Material is steel or aluminum, design pressure is 240-312 psig, test pressure is 480 psig minimum, safety factor is 4:1, and relief valve is typically 375 psig.

Cylinder Markings and Requalification

Cylinder Markings

- TC or DOT specification
- Serial number
- Manufacture date
- Test date
- Tare weight
- Water capacity
- Requalification marks

Requalification Requirements

Visual inspection required every 5, 10, or 12 years depending on cylinder type. Hydrostatic testing if required with stamping of new date. Cylinders must be current for filling.

Valve Types

POL Valve (obsolete)

Left-hand thread with no excess flow protection. Being phased out and not on new cylinders.

ACME/Type 1 Valve

Right-hand thread with external ACME thread, internal POL thread, excess flow protection, and thermal protection.

Quick-Connect Valve

Push-to-connect with automatic shut-off. Common on RV cylinders with various styles and built-in safety features.

ASME Tank Specifications

ASME tanks are designed for stationary installations and built to American Society of Mechanical Engineers standards.

Nominal Size	Water Capacity	Propane Capacity	Dimensions
120 gal	499 lbs	96 gal	54"D × 44"L
250 gal	1040 lbs	200 gal	30"D × 94"L
500 gal	2080 lbs	400 gal	37"D × 119"L
1000 gal	4160 lbs	800 gal	41"D × 192"L
2000 gal	8320 lbs	1600 gal	48"D × 293"L

Tank Construction: Material is carbon steel with wall thickness of 1/4" minimum. Heads are dished or hemispherical. Design pressure is 250 psig with test pressure of 325 psig.

Required Tank Appurtenances

01

Fill Valve

1¼" or 1¾" ACME with back-check valve, excess flow protection, and double back-check available

02

Relief Valve

Sized per code, 250 psig start-to-discharge, full relief at 375 psig, rain cap required, annual inspection mandatory

03

Service Valve

Vapor or liquid withdrawal with excess flow protection, manual shutoff, and pressure gauge port

04

Fixed Liquid Level Gauge

80% maximum fill with dip tube design, bleed valve operation, used during filling

05

Float Gauge

Percentage indication, magnetic or mechanical, remote reading available, not for filling

Underground Tank Requirements

Coating and Protection

Epoxy or polyurethane coating with cathodic protection required for corrosion resistance

Installation Depth

Minimum 6" cover, concrete anchors if required to prevent flotation in high water table areas

Access and Valves

Special valves and dome required with access risers needed for service and inspection

Leak Detection

Leak detection systems should be considered for environmental protection and early problem identification

Tank Sizing Methods

Proper tank sizing ensures adequate supply without excessive cost. Three primary factors must be considered:

Peak Load

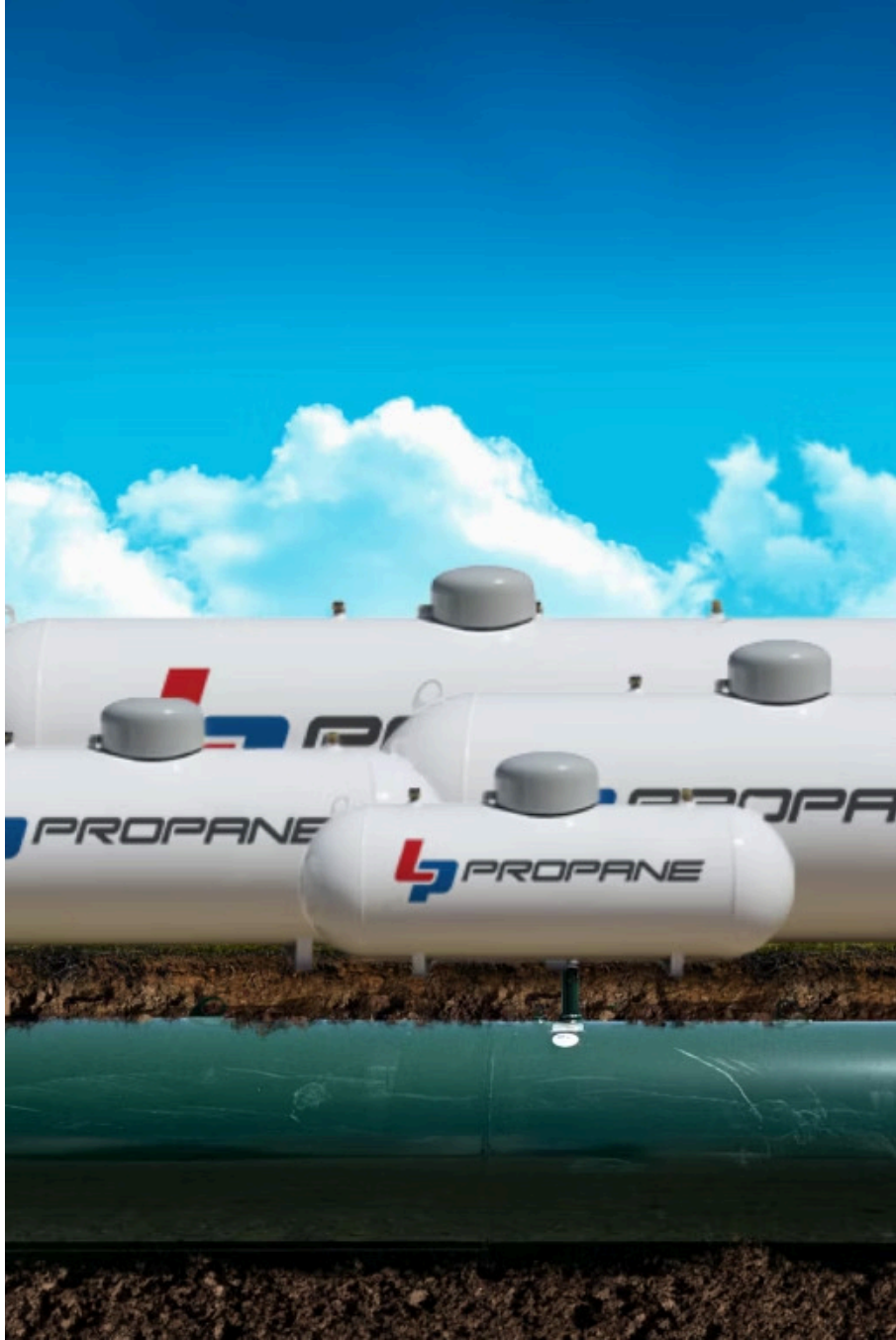
Maximum hourly demand with all appliances operating, future additions considered, and safety factor of 1.25 applied

Vaporization Rate

Ambient temperature, tank wetted surface, continuous vs. intermittent operation patterns

Storage Capacity

Days between deliveries, seasonal variations, emergency reserve, and delivery availability



Fill Limits and Ullage

Maximum Fill Regulations

CSA B149.2 Requirements: Maximum fill is 80% by volume to allow for liquid expansion. Temperature correction is required using fixed liquid level gauge. Automatic fill stop devices are available.

Volume Correction Factors

Liquid Temp	Correction Factor
-40°F	0.867
0°F	0.919
20°F	0.946
40°F	0.973
60°F	1.000
80°F	1.029
100°F	1.058

Example Calculation

500 gal tank at liquid temperature of 30°F with correction factor of 0.960:

Maximum gallons = 500 × 0.80 × 0.960 = 384 gallons

Ullage Space Functions

- Liquid expansion space
- Vapor space for withdrawal
- Safety margin
- Pressure relief operation
- Prevents liquid relief

Overfilling Hazards and Prevention

Overfilling Hazards

- Liquid discharge from relief valve
- Hydraulic tank rupture possible
- No vapor for vapor service
- Increased fire hazard
- Environmental damage

Prevention Methods

- Fixed liquid level gauge
- Automatic stop-fill valves
- Percentage gauges
- Proper delivery procedures
- Driver training programs

Tank Placement Requirements

Proper tank placement per CSA B149.2 ensures safety and accessibility.

Tank Size	From Buildings	From Property Line	Between Tanks
<125 gal	10 feet	10 feet	3 feet
125-500 gal	10 feet	10 feet	3 feet
501-2000 gal	25 feet	10 feet	3 feet
2001-30,000 gal	50 feet	25 feet	5 feet

Distances from Ignition Sources

Air intakes: 10 feet minimum | Direct vent appliances: 10 feet | Windows/doors: 10 feet | Electrical sources: 10 feet | Property lines: 10 feet minimum

Special Considerations: Distances measured from relief valve horizontally. May be reduced with barriers. Local codes may vary. Insurance requirements must be met.

Setback Distances

Factors Affecting Setbacks

Tank Capacity

Larger tanks require greater distances based on water capacity. Aggregate capacity for multiple tanks. Relief valve capacity considered. Fire exposure calculations required.

Building Factors

Occupancy type, construction type, fire rating, openings present, and height considerations all affect required setbacks.

Reduction Methods

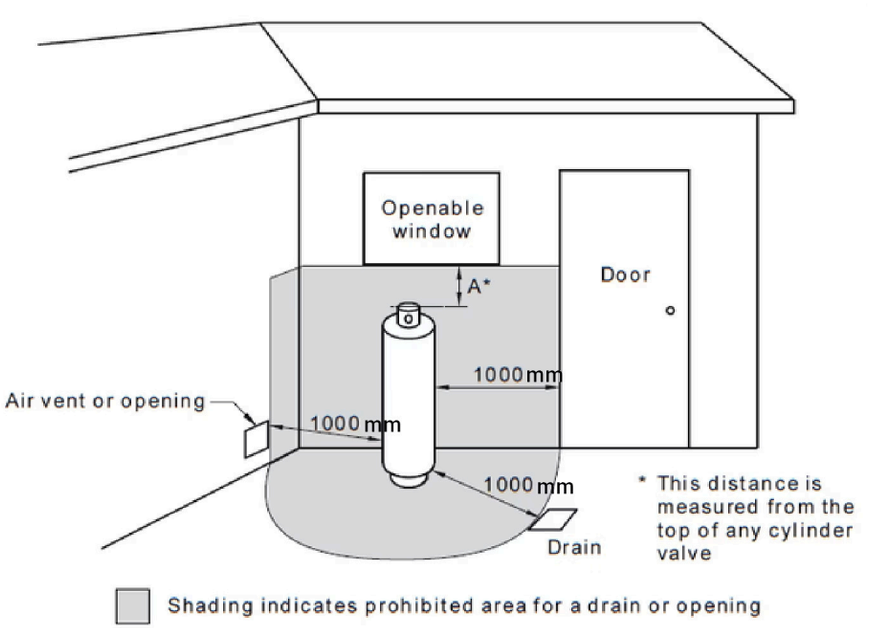
Fire Walls

2-hour rating minimum, extends 1 foot beyond tank, height per code, no openings, reduces distance 50%.

Underground Installation

Eliminates some distances, cover requirements, vehicular traffic protection, special equipment needed, higher installation cost.

Distances for Openings



Underground Tank Installations

Excavation

Depth: 6" minimum cover, width: tank diameter + 2 feet, length: tank length + 4 feet, stable soil required, dewatering if needed

Bedding

6" sand or pea gravel, compacted base, no rocks or debris, level surface, drainage considered

Tank Preparation

Coating inspection, soap test for leaks, anodes installed, risers attached, valves protected

Placement

Crane or excavator, careful lowering, proper orientation, no coating damage, temporary supports

Backfilling

Clean fill material, 6" lifts compacted, no damage to coating, risers plumb, proper cover depth

Underground Tank Corrosion Protection

Coating Systems

Epoxy coating, polyurethane coating, fiberglass wrapping, multiple coats, and holiday testing required for quality assurance

Sacrificial Anodes

Magnesium anodes common, connected to tank, 30-year life typical, testing required, replacement possible

Impressed Current

External power source, permanent anodes, adjustable protection, monitoring required, professional design

Testing Requirements

Initial testing, annual monitoring, -850 mV criterion, records maintained, professional testing

Special Considerations: High water table requires anchoring with concrete deadmen and buoyancy calculations. Vehicular traffic requires minimum 3 feet cover with possible concrete slabs. Access requirements include dome covers at grade with riser extensions for service accessibility.

18.3 Propane Regulators

Regulators reduce and control propane pressure for safe appliance operation. Understanding regulator fundamentals, proper selection, and installation requirements ensures reliable system performance.

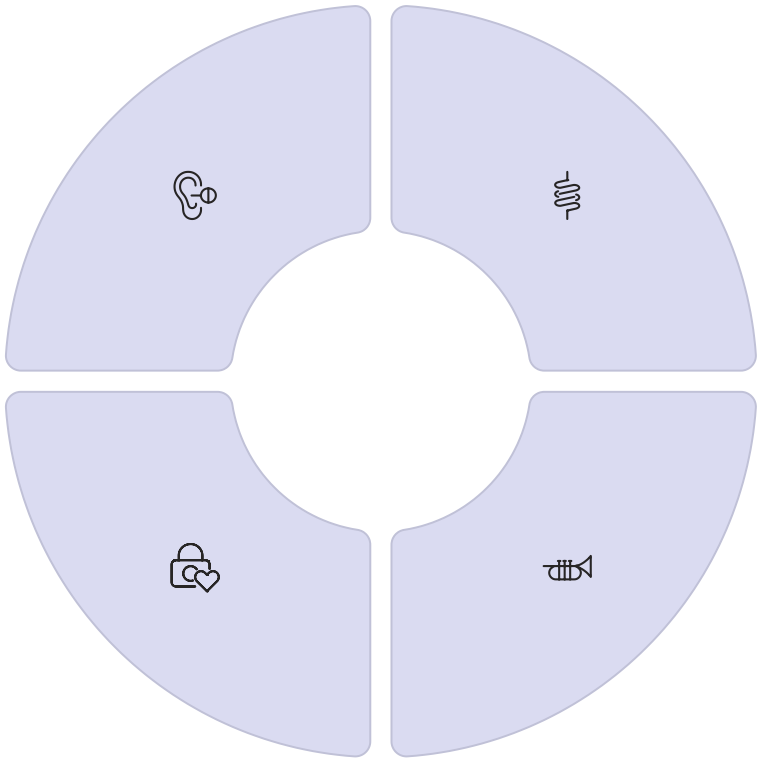
Regulator Fundamentals

Diaphragm

Flexible membrane separates chambers and transmits force. Various materials available with size affecting capacity.

Loading Spring

Provides set force, adjustable or fixed, determines outlet pressure. Spring rate critical, temperature compensated.



Relief Valve

Internal or external, protects downstream, set above outlet pressure, vents to atmosphere. Required by code.

Orifice and Seat

Controls gas flow, precision machined, various materials, replaceable design. Size affects capacity.

Operating Sequence: Spring force opens orifice → Gas flows through regulator → Downstream pressure builds → Pressure opposes spring → Equilibrium reached → Flow variations compensated

First-Stage Regulators

Specifications

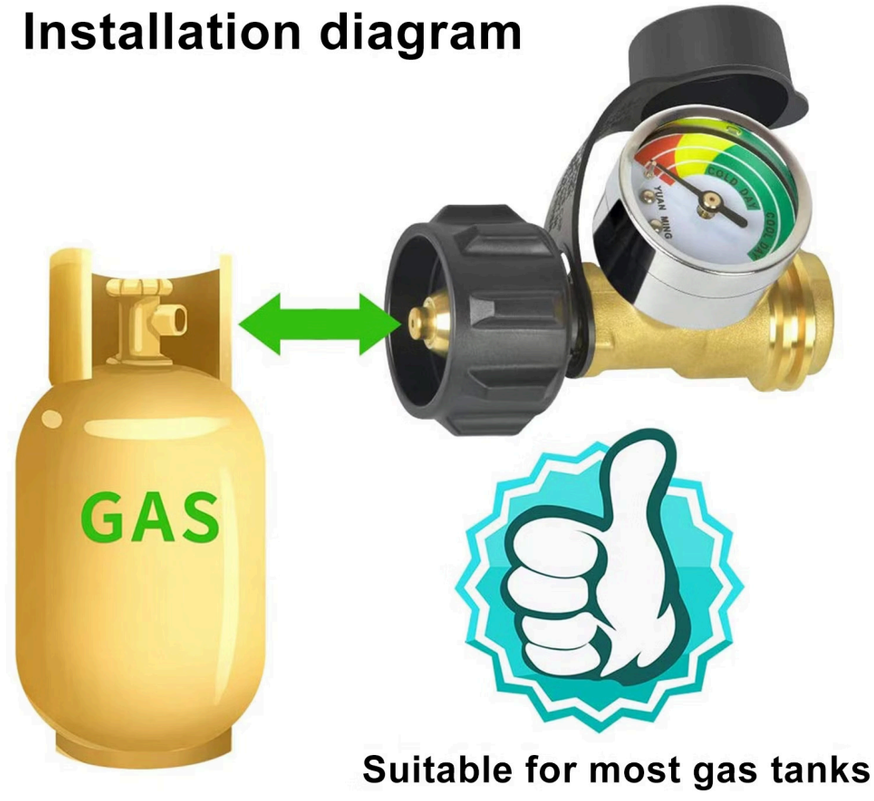
- Inlet: 250 psig maximum
- Outlet: 10 psi typical
- Relief: 30 psi typical
- Temperature: -40°F to 140°F
- Materials: Aluminum or zinc

Features

- Inlet filter screen
- Vent limiting device
- Integral relief valve
- Pressure tap
- Adjustable outlet

Capacity Ratings

Orifice Size	Capacity (BTU/hr)
3/32"	150,000
1/8"	300,000
3/16"	675,000
1/4"	1,200,000
5/16"	1,875,000



First-Stage Installation

1. **Location**

   At tank or nearby, protected from damage, accessible for service, above snow line, vent pointed down

2. **Orientation**

   Vent downward, level installation, flow arrow observed, proper support, adequate service space

3. **Venting**

   Point away from openings, minimum 5 feet from intakes, protected from blockage, screen if required, regular inspection

4. **Piping Connections**

   Proper thread sealant, no overtightening, union recommended, flexible connector, excess flow valve upstream

Cold Weather Considerations: Moisture in gas can cause regulator icing and reduced capacity. Prevention methods include methanol injection, approved heat tape, protective housing, and regular maintenance.

Second-Stage Regulators

Single Second-Stage

Inlet: 10 psi, Outlet: 11" W.C., Various capacities, Internal relief, Adjustable settings

Integral Two-Stage

Combined unit, Compact design, Single vent, Cost effective, Limited capacity

Line Regulators

Individual appliance, 2 psi systems, Special applications, Compact size, Various pressures

Selection Criteria

Sizing Example: Connected load of 350,000 BTU/hr with diversity factor of 0.7 gives design load of 245,000 BTU/hr. Select 1/2" regulator rated for 300,000 BTU/hr.

Features to Consider: Vent limiting device, over-pressure protection, integral relief, token relief, and screen protection ensure safe operation.

- 2-Stage design for more flow of propane gas
- Safe and Secure connect
- 160,000 BTU/HR capacit

Integral Two-Stage Regulators

Advantages

- Single unit installation
- Compact design
- Single vent location
- Cost effective
- Simplified piping
- Consistent performance
- Factory adjusted
- Reduced leak potential

Applications

Residential systems, small commercial installations, limited space situations, single tank systems, and replacement installations.

Limitations

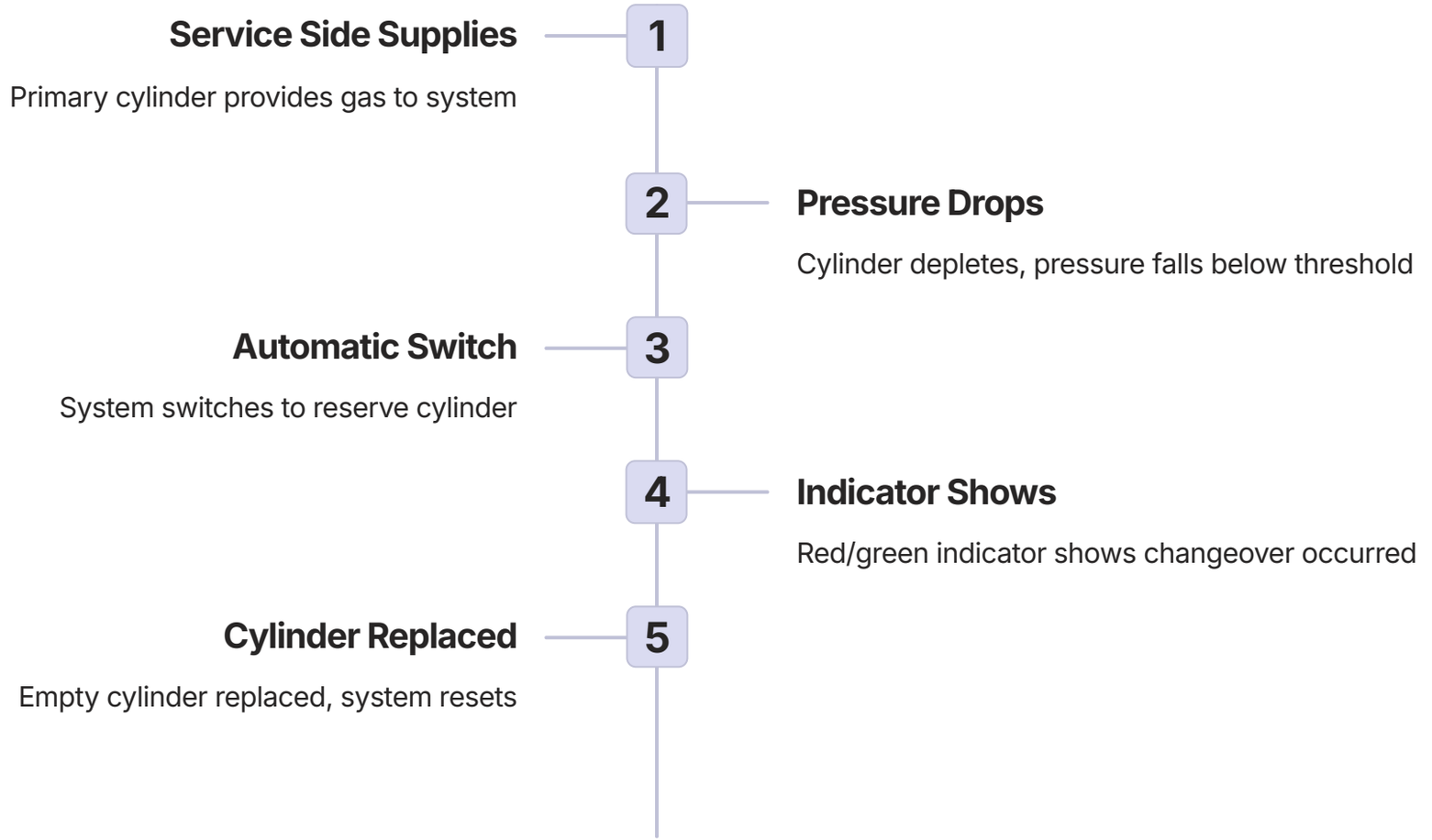
- Limited capacity
- Both stages fail together
- Less flexibility
- Difficult troubleshooting
- Higher replacement cost

Capacity Limits

Typically under 1,000,000 BTU/hr for single tank applications with shorter distances, fewer appliances, and standard pressures only.

Automatic Changeover Regulators

Provides continuous supply from multiple cylinders with automatic switching.



Components: Two-stage regulator, changeover valve, check valves, indicator system, pigtails, and mounting bracket. Typical capacity is 200,000 BTU/hr with changeover at 10 psig.

Applications: Residential continuous supply, remote locations, vacation homes, critical heating, commercial restaurants, small businesses, emergency systems, RV and marine installations.

Relief Valve Requirements

Code Requirements

CSA B149.2 requires relief valves on all regulators, either internal or external, sized for capacity with specified set pressure and annual inspection.

Relief Valve Settings

First stage outlet: 30 psi | Second stage outlet: 2 psi | Appliance regulator: 1 psi | Two-stage integral: 2 psi

Types of Relief

Internal relief built into regulator, external relief as separate component, token relief for minimal flow warning function

Sizing Requirements

Capacity calculation based on regulator size, orifice area, set pressure, full flow conditions, and safety factor.

Regulator Size	Required Relief (CFH)
3/8"	500
1/2"	800
3/4"	1,500
1"	2,500
1¼"	3,500

Regulator Venting

Vent Requirements

Code Requirements: Must terminate outdoors, away from ignition sources, protected from blockage, accessible for inspection, and use proper materials.

Distances: 5 feet from openings, 10 feet from air intakes, 3 feet from grade, away from alcoves, and clear of snow line.

Vent Piping

Materials: Copper tubing, steel pipe, flexible tubing (limited), corrosion resistant, and proper support.

Sizing: Minimum 5/16" tubing based on relief capacity, maximum 30 feet, minimal elbows, and no traps.

Vent Protection Devices

Vent Limiting Devices: Limits gas escape, required in some areas, various designs, automatic reset, and manual types available.

Vent Protectors: Weather protection, screen protection, prevents blockage, removable for service, and various designs.

Common Problems

- Spider webs
- Mud dauber nests
- Ice formation
- Paint blockage
- Corrosion

18.4 Propane Piping

Proper piping design and installation ensure safe and adequate gas delivery. Material selection per CSA B149.2, correct sizing methods, and proper installation techniques are essential for code-compliant systems.

Material Selection per CSA B149.2

Steel Pipe

Schedule 40 minimum, black or galvanized, ASTM A53 or A106, threaded or welded. Most common material for above ground, below ground (coated), high pressure, commercial/industrial, and long runs.

Copper Tubing

Type K or L (no Type M), flare fittings required, limited to 100 psig. Common in residential for above ground, below ground, flexible installation, and corrosion resistant applications.

CSST

Corrugated Stainless Steel Tubing - certified systems only, special fittings, lightning protection required, flexible installation. Labor saving for interior only residential/commercial, retrofits, and earthquake zones.

Polyethylene (PE)

Underground only, SDR 11 minimum, special fittings, tracer wire required, long life. Used for underground mains, distribution systems, yard lines. Non-metallic preferred, corrosion immune.

Prohibited Materials: Cast iron pipe, PVC pipe, aluminum tubing, galvanized steel (underground), lead pipe, and rubber hose (except listed types) are not acceptable for propane piping.

Sizing Propane Piping

Design Factors

Total Load

All connected appliances, future additions, diversity factors, and peak demand

Allowable Pressure Drop

0.5" W.C. residential, 1.0" W.C. commercial, 10% high pressure

Pipe Length

Measured length, fitting equivalents, total equivalent length

Specific Gravity

Propane: 1.52, correction required from natural gas tables

Capacity in CFH (Propane) - Schedule 40 Pipe at 11" W.C.:

Pipe Size	20 ft	40 ft	60 ft	80 ft	100 ft
1/2"	235	160	129	110	98
3/4"	490	336	273	234	208
1"	925	636	516	443	393
1¼"	1,900	1,305	1,060	910	807
1½"	2,750	1,890	1,535	1,318	1,169
2"	4,500	3,093	2,513	2,157	1,913

Specific Gravity Correction Factors

Correction Formula

Propane requires correction from natural gas sizing tables:

Propane Capacity = Natural Gas Capacity × √(0.60/1.52)

Propane Capacity = Natural Gas Capacity × 0.63

Application Example

Natural gas table shows: 1,000 CFH

Propane correction: 1,000 × 0.63

Propane capacity: 630 CFH

Pressure Correction

Inlet Pressure	Pressure Drop	Multiplier
11" W.C.	0.5" W.C.	1.00
2 psi	3.5" W.C.	2.04
5 psi	1 psi	3.23
10 psi	1 psi	4.47

Temperature Correction

Gas Temperature	Correction Factor
32°F	1.07
50°F	1.00
70°F	0.93
90°F	0.87

Vapor Piping vs. Liquid Piping

Vapor Piping Systems

Characteristics

- Low pressure (under 125 psi)
- Larger pipe sizes
- Standard materials
- Simple installation
- Most common type

Design Considerations

- Pipe sizing critical
- Pressure drop limits
- Condensation drainage
- Thermal expansion
- Support requirements

Installation

Slope for drainage, drip legs if required, proper supports, protection from damage, and comprehensive testing requirements.

Liquid Piping Systems

Characteristics

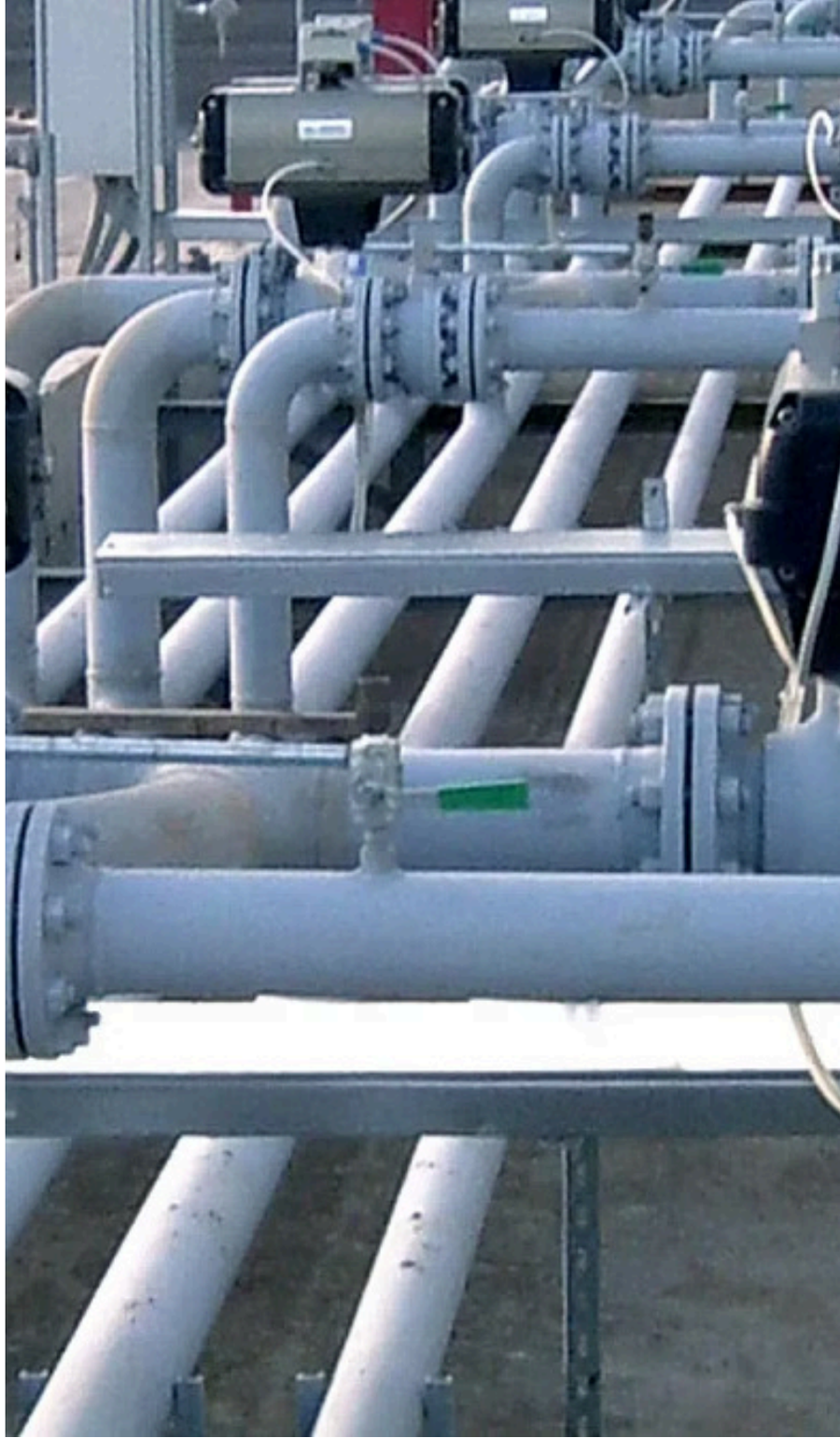
- High pressure (up to 250 psi)
- Smaller pipe sizes
- Special materials
- Safety considerations
- Limited applications

Design Requirements

- Hydrostatic relief valves
- Every 50 feet maximum
- Between shutoff valves
- Thermal expansion protection
- Excess flow valves

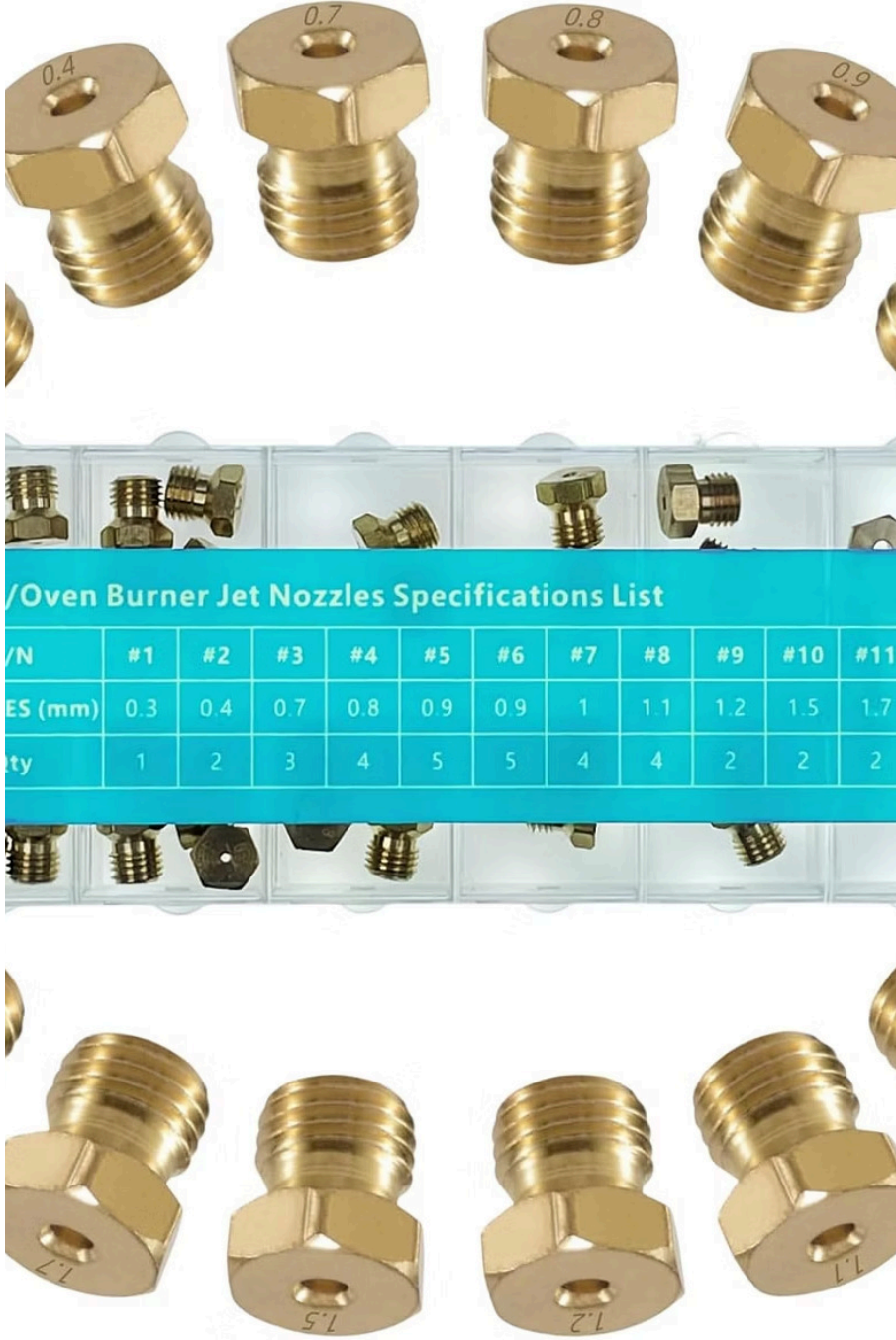
Materials

Schedule 80 steel, seamless copper, special fittings, welded preferred, and pressure ratings verified.



18.5 Propane Appliance Conversion

Converting appliances between fuel types requires careful attention to safety and performance. Many appliances can be converted between natural gas and propane with proper conversion kits and procedures.



Conversion Feasibility

Convertible Appliances

- Most residential furnaces
- Water heaters
- Ranges and cooktops
- Dryers
- Some commercial equipment

Non-Convertible Appliances

- High-efficiency furnaces (some)
- Sealed combustion units (some)
- Certain imported appliances
- Old equipment
- Units without conversion kits

Manufacturer Requirements

- Conversion kit available
- Instructions provided
- Certification maintained
- Warranty considerations
- Technical support

Conversion Kit Components: Main burner orifices, pilot orifice, gas valve springs, regulator springs, conversion labels, rating plate updates, step-by-step instructions, specifications, adjustment procedures, testing requirements, and troubleshooting guides.

Orifice Changes

Orifice sizing is critical for proper combustion. Propane orifices are smaller due to higher heat content (2,516 BTU/ft³ vs 1,000), higher pressure (11" W.C. vs 7" W.C.), and different specific gravity (1.52 vs 0.60).

Common Orifice Sizes

BTU Rating	Natural Gas	Propane
10,000	#42 (0.094")	#54 (0.055")
20,000	#35 (0.110")	#48 (0.076")
30,000	#30 (0.129")	#44 (0.086")
40,000	#26 (0.147")	#41 (0.096")

Size Reduction: Natural gas to propane requires approximately 0.63 area ratio, which is 1.5 to 2 drill sizes smaller. Varies by appliance - must use kit orifices.

Orifice Identification: Stamped size, drill number, decimal size, color coding, and part numbers help identify correct orifices.

Pressure Adjustments

Gas Valve Adjustments

Manifold Pressure:

Natural Gas: 3.5" W.C.

Propane: 10.0" W.C.

Adjustment Procedure

1. Connect manometer
2. Remove regulator cap
3. Start appliance
4. Adjust regulator screw
5. Clockwise increases pressure
6. Set to specification
7. Replace cap
8. Verify operation

Multi-Stage Equipment

- High fire adjustment
- Low fire adjustment
- Modulating controls
- Electronic calibration
- Factory consultation

Pilot Adjustment

- Flame characteristics
- Thermocouple engulfment
- Proper impingement
- Stable operation
- Safety shutdown test

Propane meter

Combustion Testing Post-Conversion

Required Tests

11

Inlet Pressure

Inches of water column at appliance inlet

10

Manifold Pressure

Inches of water column at burner manifold

<100

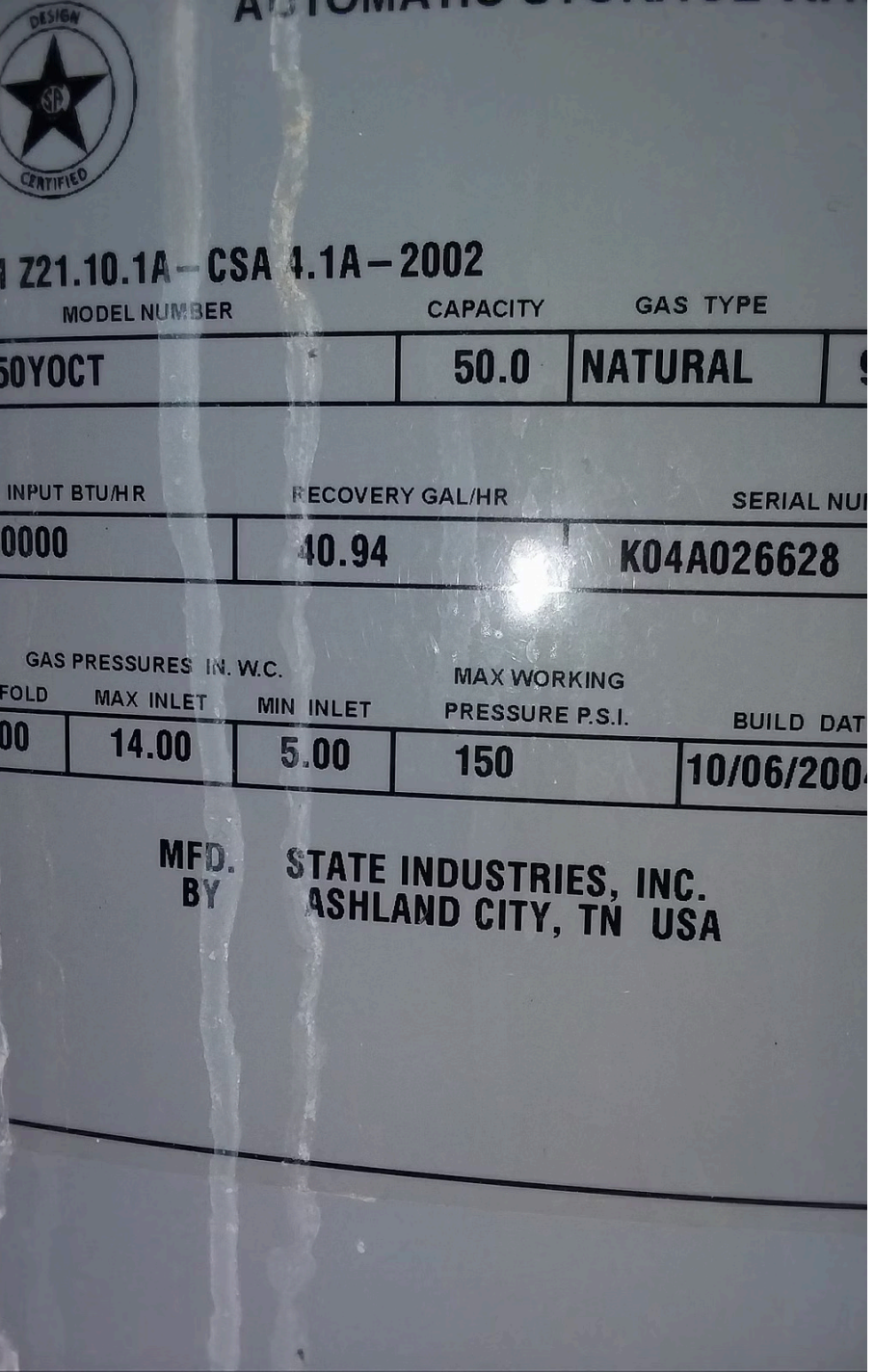
CO Level

Parts per million air-free carbon monoxide

Acceptable Combustion Parameters

Parameter	Acceptable Range
CO	<100 ppm air-free
O_2	5-9%
CO_2	8-11%
Stack temp	350-500°F
Draft	-0.02" to -0.04"

Flame Characteristics: Blue flame with minimal yellow tips, stable flame with no lifting or flashback, and proper impingement on heat exchanger surfaces.



Labeling Requirements

1

Conversion Label

Must state "CONVERTED TO PROPANE" with date of conversion, technician name, company name, and phone number. Adjacent to rating plate in visible, permanent, weather-resistant location.

2

Rating Plate Update

Cross out old fuel, mark new fuel, update input if changed, note new orifice sizes, and maintain legibility of all information.

3

Additional Labels

Gas type at shutoff, regulator settings, special instructions, warning labels, and service reminders as required.

4

Documentation

Conversion certificate with appliance information, conversion kit used, test results, customer signature, and copy provided to customer.

18.6 Cylinder Storage and Handling

Safe cylinder handling prevents accidents and ensures code compliance. Proper storage requirements, transportation regulations, and safe handling procedures protect workers and the public.

Storage Requirements

Outdoor Storage Location Requirements

Well-ventilated area, away from buildings, no basement storage, level surface, and secured from falling.

Quantity Stored	From Buildings	From Property Line
<500 lbs	0 feet	0 feet
500-2,500 lbs	10 feet	10 feet
2,500-10,000 lbs	25 feet	25 feet
Over 10,000 lbs	50 feet	50 feet

Storage Arrangements: Upright position, valve protection, separated full/empty, first in first out rotation, and clear access paths maintained.

Weather Protection: Out of direct sun, protected from rain, above snow line, ventilated enclosure, and no heat sources nearby.

Transportation Regulations (TDG)

Classification

Class 2.1: Flammable gas, UN1978: Propane, Packing group: N/A, Placarding required >500 kg

Driver Requirements

<500 kg: Valid driver's license | ≥500 kg: TDG certificate | Bulk: Commercial endorsement

Vehicle Requirements

Ventilated vehicle, secured cylinders, upright position, no smoking, fire extinguisher required

Documentation

Shipping document, emergency response info, 24-hour phone number, product identification, quantity declaration

Cylinder Transport in Vehicles: Maximum 5 cylinders with total 500 kg limit. Secured upright with valve protection and ventilation required. Prohibited in closed trunks, passenger compartments, public transit, and unattended vehicles without valve caps.

18.7 Propane System Commissioning

Proper commissioning ensures safe system operation and code compliance. Pre-commissioning checks, comprehensive leak testing, and proper documentation verify system integrity before activation.

Leak Testing and Pressure Testing

01

Pressure Drop Test

Isolate system section, pressurize to test pressure, record initial pressure, wait 15 minutes minimum, record final pressure, calculate drop. No pressure drop acceptable.

02

Soap Bubble Test

Apply commercial leak detector or dish soap solution to all joints, valve stems, regulator connections, relief valves, gauge connections, and appliance connections.

03

Electronic Detection

Use calibrated combustible gas detector with proper sensitivity for systematic coverage. Document all readings.

04

Documentation

Record date and time, test pressure, duration, results, technician signature, and inspector signature for all testing.

Test Pressures and Duration

Low Pressure (11" W.C.): Test at 15" W.C. for 15 minutes with no pressure drop. All appliances connected.

Medium Pressure (2 psi): Test at 3 psi for 30 minutes using 0-5 psi gauge. All sections tested with recorded results.

High Pressure (10 psi): Test at 15 psi for 60 minutes using 0-30 psi gauge. Temperature recorded with witnessed test.