# CHAPTER 6

# Gas Piping Materials and Methods

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## Learning Objectives

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

1. Identify approved piping materials for natural gas and propane installations
2. Select appropriate piping materials for different applications
3. Calculate pipe sizes using CSA B149.1 sizing tables
4. Apply pressure drop calculations for gas piping systems
5. Install black steel pipe with proper threading and joint compound
6. Install corrugated stainless steel tubing (CSST) per manufacturer specifications
7. Install polyethylene (PE) pipe for underground applications
8. Understand support spacing and protection requirements
9. Apply proper bonding and grounding for CSST systems
10. Install gas piping in compliance with CSA B149.1 requirements

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## 6.1 Approved Piping Materials

CSA B149.1 specifies approved materials for gas piping. Selection depends on application, location (indoor/outdoor, above/below ground), and local requirements.

### Black Steel Pipe

**Most Common Material for Indoor Gas Piping**

**Specifications:**

- ASTM A53, Grade B or ASTM A106, Grade B
- Seamless or welded
- Black finish (not galvanized)
- Threaded connections (NPT threads)
- Standard wall thickness (Schedule 40)

**Sizes:**

- 1/8" through 12" (larger for commercial/industrial)

- Residential typically 1/2" through 1-1/4"
- Nominal sizes (not actual dimensions)

**Advantages:**

- Strong and durable
- Widely available
- Proven track record
- Long service life
- High pressure rating
- Familiar to installers

**Disadvantages:**

- Requires threading
- Heavier than alternatives
- Can corrode (especially underground without protection)
- Rigid (difficult in tight spaces)
- Labor-intensive installation

**Applications:**

- Indoor piping (primary use)
- Above-ground outdoor (with protection)
- Exposed piping
- Commercial/industrial
- High-pressure applications

**Why Not Galvanized:**

- Galvanizing (zinc coating) flakes off over time
- Flakes can plug orifices, damage regulators
- Prohibited by CSA B149.1
- Black pipe only for gas

## Corrugated Stainless Steel Tubing (CSST)

**Flexible Alternative to Black Steel**

**Description:**

- Thin-wall stainless steel tubing
- Corrugated (accordion-like) for flexibility
- Yellow or black jacket (PE coating)
- Factory lengths with fittings attached or field-installed fittings
- Various manufacturers (TracPipe, Gastite, WarFlex, etc.)

**Sizes:**

- Designated by inside diameter flow capacity
- 3/8", 1/2", 5/8", 3/4", 1", 1-1/4" nominal
- Must use manufacturer's sizing charts

**Advantages:**

- Flexible (bends around obstacles)
- Faster installation than threaded pipe
- Lighter weight
- No threading required
- Long continuous runs (reduces fittings)
- Corrosion resistant

**Disadvantages:**

- More expensive than black steel
- Requires special tools (striker/crimping tool)
- Must use manufacturer's fittings
- Can be damaged by physical impact
- Requires bonding/grounding (electrical safety)
- Not all jurisdictions permit
- Must be protected from damage

**Installation Requirements:**

- Follow manufacturer's instructions exactly
- Use manufacturer's fittings only
- Support per manufacturer specifications (typically 4-6 ft)
- Protect from physical damage
- **MUST be bonded per CSA B149.1 Clause 7.11**
- Cannot contact sharp edges
- Cannot be buried underground (in most cases)
- Jacketed CSST may be run through walls

**Bonding and Grounding:**

- Required by CSA B149.1
- Protects against lightning strikes and electrical faults
- Bonding clamp at CSST entry point
- Conductor to electrical ground
- #6 AWG copper minimum
- Electrician may be required
- Critical safety requirement

**Applications:**

- Residential installations
- Light commercial
- Retrofit installations (easier routing)
- Where flexibility needed
- Indoor installations primarily

## Polyethylene (PE) Pipe

### Underground Gas Piping

**Specifications:**

- PE 2708 or PE 4710 rated for gas
- Yellow color (gas identification)
- Various pressure ratings
- SDR 11 (Standard Dimension Ratio) common for gas

**Sizes:**

- 1/2" through 6" CTS (Copper Tube Size) for gas distribution
- Larger for transmission lines
- Size marking on pipe

**Advantages:**

- Corrosion-proof
- Flexible
- Long continuous lengths
- Heat-fused joints (no leaks)
- Lightweight
- Lower cost than steel underground
- Excellent for underground service lines

**Disadvantages:**

- Underground use only (except approved cases)
- Requires fusion equipment
- Training required for proper fusion
- Can be damaged by rocks during backfill
- Must transition to steel above ground
- Requires tracer wire (not detectable by metal detector)

**Installation Requirements:**

- Yellow jacket (gas identification)
- Minimum depth per code (typically 18" below frost line)
- Sand bedding if rocky soil
- Protected from sharp objects
- Tracer wire (copper) for locating
- Transition to steel minimum 12" above grade
- Cannot be threaded (heat fusion only)
- Test per code requirements

**Heat Fusion:**

- Butt fusion (pipe to pipe)
- Socket fusion (pipe to fitting)
- Electrofusion (fitting with built-in heater)
- Proper temperature and time critical
- Visual inspection required
- Training and certification recommended

**Applications:**

- Underground service lines
- Distribution mains
- Residential gas services
- Farm gas lines
- Where corrosion is concern

## Copper Tubing

**Limited Use in Gas Installations**

**Specifications:**

- Type K or Type L (wall thickness)
- ACR (Air Conditioning & Refrigeration) quality
- Hard-drawn or annealed

**Approved Joining Methods:**

- Brazed joints (silver alloy, not soft solder)
- Flared fittings (mechanical)
- Compression fittings (limited applications)
- **NOT soft-soldered** (solder melts at low temperature)

**Limitations:**

- Not permitted in some jurisdictions

- Natural gas may cause copper corrosion in some conditions
- Limited pressure rating
- More expensive than steel
- Requires brazing skills

**Applications (where permitted):**

- Propane installations (more common)
- Above-ground only
- Protected locations
- Short runs
- Appliance connections

**CSA B149.1 Requirements:**

- Type K or L only (Type M not permitted)
- Properly joined (brazed or flared)
- Protected from physical damage
- Limited to specific applications per local code

## Flexible Appliance Connectors

### Short Connections to Moveable Appliances

**Description:**

- Flexible metal hose
- Corrugated or smooth wall
- Various lengths (typically 2-6 feet maximum)
- Factory-installed fittings
- Listed and approved for gas

**Specifications:**

- CSA certified for gas use
- Length limitations per code
- Cannot pass through walls, floors, ceilings
- Must be visible and accessible

**Applications:**

- Ranges and cooktops
- Dryers
- Other moveable appliances
- Where appliance must be moved for service

**Installation Requirements:**

- Maximum length per code (typically 6 ft)
- Must be accessible for inspection
- Cannot be concealed
- Proper support
- Not subject to damage
- Shut-off valve at rigid piping

**Prohibited Uses:**

- Permanent connections
- Connections through walls
- Underground
- Long runs
- As substitute for rigid piping

### Prohibited Materials

**Materials NOT Approved for Gas Piping:**

- **Galvanized steel pipe** (zinc flakes plug orifices)
- **PVC, ABS, and plastic pipes** (above ground)
- **Copper soft solder joints** (solder melts)
- **Aluminum pipe** (except specific applications)
- **Cast iron pipe** (brittle, old systems only)
- **Rubber or vinyl hose** (except approved appliance connectors)
- **Garden hose** (obviously unsafe)
- **Unapproved flexible connectors**

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## 6.2 Pipe Sizing Principles

Proper pipe sizing ensures adequate gas flow at correct pressure. Undersized pipe causes pressure drop; oversized pipe is wasteful.

### Factors Affecting Pipe Size

**1. Gas Flow Rate (Demand):**

- Total BTU/hr input of all appliances
- Determines cubic feet per hour (CFH) needed
- Must size for maximum simultaneous demand

**2. Pipe Length:**

- Longer run = more friction = larger pipe needed
- Measure from meter/regulator to farthest appliance
- "Longest run" method or branch lengths

**3. Allowable Pressure Drop:**

- Maximum pressure loss allowed in system
- Inlet pressure minus minimum appliance requirement
- Typical: 0.5" W.C. for low pressure systems
- More drop allowed in higher pressure systems

**4. Specific Gravity:**

- Natural gas: 0.60
- Propane: 1.52
- Different tables for each
- Affects flow calculations

**5. Supply Pressure:**

- Inlet pressure at meter/regulator
- Natural gas: typically 7" W.C.
- Propane: typically 11" W.C.
- Higher pressure = smaller pipe possible

## Calculating Gas Demand

**Step 1: List All Appliances and Inputs**

Example residence:

- Furnace: 100,000 BTU/hr
- Water heater: 40,000 BTU/hr
- Range: 65,000 BTU/hr
- Dryer: 35,000 BTU/hr

**Step 2: Determine Simultaneous Demand**

Not all appliances operate at once continuously:

- Furnace and water heater: likely simultaneous
- Range: intermittent use
- Dryer: intermittent use

**Conservative Approach:** Size for all appliances Total = 100,000 + 40,000 + 65,000 + 35,000 = 240,000 BTU/hr

**Alternative:** Engineering judgment for intermittent loads (Less conservative, not recommended for residential)

**Step 3: Convert to Cubic Feet per Hour**

For Natural Gas (1,000 BTU/ft³): CFH = BTU/hr ÷ 1,000 CFH = 240,000 ÷ 1,000 = 240 CFH

For Propane (2,500 BTU/ft³): CFH = BTU/hr ÷ 2,500 CFH = 240,000 ÷ 2,500 = 96 CFH

## Using CSA B149.1 Sizing Tables

**Table Selection:**

- Natural gas or propane
- Supply pressure (e.g., 7" W.C. inlet)
- Allowable pressure drop (e.g., 0.5" W.C.)
- Specific gravity (if different from table)

**Table Format:**

- Rows: Pipe sizes (1/2", 3/4", 1", etc.)
- Columns: Pipe lengths (10', 20', 30', etc.)
- Values: Maximum capacity in cubic feet per hour (CFH)

**Example Natural Gas Table Excerpt (7" W.C. inlet, 0.5" W.C. drop, 0.60 SG):**

| Pipe Size | 10 ft | 20 ft | 30 ft | 40 ft | 50 ft | 60 ft |
|---|---|---|---|---|---|---|
| 1/2" | 132 | 92 | 73 | 63 | 56 | 50 |
| 3/4" | 278 | 190 | 152 | 130 | 115 | 105 |
| 1" | 520 | 360 | 285 | 245 | 215 | 195 |
| 1-1/4" | 1,050 | 730 | 580 | 500 | 440 | 400 |

(Values are approximate examples; always use current CSA B149.1 tables)

## Longest Run Method

**Most Common Sizing Method:**

**Step 1: Identify Longest Run**

- Measure from meter to farthest appliance
- Include all pipe, fittings, valves
- Fittings add equivalent length

**Step 2: Determine Total Demand**

- Sum all appliance inputs on system

**Step 3: Select Pipe Size**

- Use table for longest run length
- Find pipe size that handles total demand
- Use next larger size if between sizes

**Example:**

System:

- Longest run: 45 ft
- Total demand: 240,000 BTU/hr = 240 CFH (natural gas)
- Supply: 7" W.C., Allowable drop: 0.5" W.C.

From table:

- 45 ft falls between 40 ft and 50 ft columns
- Interpolate or use 50 ft to be conservative
- At 50 ft: 3/4" pipe handles 115 CFH (too small)
- At 50 ft: 1" pipe handles 215 CFH (too small)
- At 50 ft: 1-1/4" pipe handles 440 CFH (adequate)

**Answer: Use 1-1/4" pipe for entire run**

**Advantages:**

- Simple
- Conservative (safe)
- Required by many jurisdictions

**Disadvantages:**

- May oversize near meter
- More material cost
- Not optimized

## Branch Length Method

**More Efficient for Complex Systems:**

Size each section based on the demand it serves and its length.

**Procedure:**

1. **Draw System:**
    - Sketch piping layout
    - Mark all appliances
    - Measure each section length
2. **Calculate Section Loads:**
    - Start at farthest appliance
    - Work back toward meter
    - Each section carries load of all appliances downstream
3. **Size Each Section:**
    - Use appropriate length and load
    - May have different sizes in different sections

**Example:**

```
Meter --- 20ft (1") --- A (Tee)
                        |
                        +-- 30ft (3/4") --- Water Heater (40 MBTUH)
                        |
                        +-- 40ft --- B (Tee)
                                     |
                                     +-- 10ft (1/2") --- Range (65 MBTUH)
                                     |
                                     +-- 20ft (1/2") --- Furnace (100 MBTUH)
```

**Section Sizing:**

**Furnace Branch (20 ft from B):**

- Load: 100,000 BTU = 100 CFH
- Length: 20 ft
- 1/2" pipe @ 20 ft = 92 CFH (adequate)

**Range Branch (10 ft from B):**

- Load: 65,000 BTU = 65 CFH
- Length: 10 ft
- 1/2" pipe @ 10 ft = 132 CFH (adequate)

**Section B to A (40 ft):**

- Load: 100 + 65 = 165 CFH
- Length: 40 ft
- 3/4" pipe @ 40 ft = 130 CFH (too small)
- 1" pipe @ 40 ft = 245 CFH (adequate)

**Wait - Need to reconsider:** Actually measure 40 ft from meter, not from B. **From meter to B: 20 + 40 = 60 ft**

**Section from Meter through A to B (60 ft):**

- Load: All appliances = 100 + 65 + 40 = 205 CFH
- Length: 60 ft
- 1" pipe @ 60 ft = 195 CFH (too small)
- 1-1/4" pipe @ 60 ft = 400 CFH (adequate)

**Water Heater Branch (30 ft from A):**

- Load: 40,000 BTU = 40 CFH
- **Length from meter: 20 + 30 = 50 ft**
- 1/2" pipe @ 50 ft = 56 CFH (adequate)

**Revised Sizing:**

- Meter to A: 1-1/4" (20 ft, carries all appliances)
- A to B: 1-1/4" (40 ft, carries furnace and range)
- A to water heater: 1/2" (30 ft, carries water heater only)
- B to range: 1/2" (10 ft)
- B to furnace: 1/2" (20 ft)

**Advantages:**

- Optimized sizing
- Lower material cost
- Still meets code

**Disadvantages:**

- More complex calculations
- More prone to errors
- Requires accurate measurements

## Equivalent Length of Fittings

Fittings add friction/resistance. Add equivalent length to straight pipe.

**Typical Equivalent Lengths:**

| Fitting | Equivalent Length (ft) |
|---|---|
| 90° Elbow | 3 ft |
| 45° Elbow | 1.5 ft |
| Tee (flow through) | 1.5 ft |
| Tee (flow through branch) | 5 ft |
| Gate valve | 0.5 ft |

| Fitting | Equivalent Length (ft) |
|---|---|
| Plug valve | 3 ft |

**Example:**

Straight pipe: 40 ft Plus: 3 elbows @ 3 ft each = 9 ft Plus: 2 tees @ 5 ft each = 10 ft Plus: 1 valve @ 3 ft = 3 ft **Total equivalent length: 40 + 9 + 10 + 3 = 62 ft**

Use 62 ft (or 60 ft column) in sizing table.

### Specific Gravity Corrections

If actual gas specific gravity differs from table, apply correction factor.

**Correction Factor:**

CF = √(Table SG ÷ Actual SG)

**Example:**

Natural gas table based on 0.60 SG Actual gas has 0.65 SG

CF = √(0.60 ÷ 0.65) = √0.923 = 0.96

Multiply table values by 0.96 to get actual capacity.

If table shows 200 CFH capacity: Actual = 200 × 0.96 = 192 CFH

**For propane:** Use propane tables (SG = 1.52), not natural gas tables with corrections.

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# 6.3 Steel Pipe Installation

Black steel pipe is the traditional and most common gas piping material.

### Threading Pipe

**Proper Threading is Critical for Leak-Free Joints**

**Thread Standard:**

- NPT (National Pipe Taper)
- Tapered 3/4" per foot
- 1/16" taper per inch of length

- Seals on tapered threads, not thread bottom

**Threading Procedure:** (Review Chapter 3 for detailed threading steps)

1. Cut pipe square
2. Ream inside burr
3. Secure in vise
4. Apply threading oil generously
5. Start die square to pipe
6. Thread to proper length
7. Back off periodically to break chips
8. Add oil continuously
9. Inspect threads

**Thread Length:**

Must engage fitting properly:

| Pipe Size | Thread Length (approximate) |
|---|---|
| 1/2" | 3/4" (9-10 threads) |
| 3/4" | 3/4" (9-10 threads) |
| 1" | 1" (10-11 threads) |
| 1-1/4" | 1" (11-12 threads) |
| 1-1/2" | 1" (11-12 threads) |
| 2" | 1" (11-12 threads) |

Too little: Won't engage properly, weak joint Too much: Bottoms out before sealing

**Thread Inspection:**

Good threads:

- Sharp and clean
- No torn or ragged edges
- Uniform taper
- Start easily in fitting by hand
- Tighten with moderate force

## Pipe Joint Compound (Pipe Dope)

**Purpose:**

- Lubricates threads for assembly
- Fills minor imperfections
- Creates seal

**Types Approved for Gas:**

- Paste compounds (most common)
- Teflon tape (with compound)
- Never use unapproved sealants

**Application:**

**Male threads only:**

- Apply to male threads
- Cover first 2-3 threads completely
- Brush or finger application
- Moderate coating (not excessive)
- **Never apply to female threads**

**Why only male threads:**

- Prevents compound from being forced into pipe
- Compound in pipe can contaminate regulators, pilots
- Keeps compound in joint, not system

**Assembly:**

1. Apply compound to male threads
2. Start fitting by hand (should thread easily)
3. Tighten with wrenches:
    - Wrench on fitting
    - Wrench on pipe
    - Turn fitting, hold pipe
4. Tighten until firm:
    - Typically 2-3 turns past hand tight
    - Not excessive force
    - Fitting should not turn easily
    - Don't crack fitting

**Common Mistakes:**

- Compound on female threads
- Insufficient compound
- No compound (will leak)
- Over-tightening (cracks fitting)
- Wrong compound (not gas-rated)

## Pipe Support and Spacing

**Support Requirements:**

CSA B149.1 specifies maximum support spacing:

**Horizontal Pipe:**

| Pipe Size | Maximum Support Spacing |
|---|---|
| 1/2" | 6 ft (1.8 m) |
| 3/4" - 1" | 8 ft (2.4 m) |
| 1-1/4" and larger | 10 ft (3 m) |

**Vertical Pipe:**

- Support at each floor
- Maximum 10 ft intervals

**Support Types:**

- Pipe straps (most common)
- Clevis hangers
- Pipe hooks (J-hooks)
- Brackets
- Must not damage pipe

**Installation:**

- Support from structure (not hanging from other piping)
- Proper size for pipe
- Allow for expansion
- Don't over-tighten (can deform pipe)
- At changes in direction

## Protection from Damage

**Physical Protection Required:**

**In Walls:**

- Steel plates if pipe closer than 1-1/4" (32 mm) from surface
- Prevents nails, screws from penetrating
- 1/16" (1.6 mm) minimum thickness
- Extends beyond pipe

**In Concrete:**

- Sleeve or wrap pipe
- Prevents concrete contact
- Allows for expansion
- Protects from chemical reaction

**Exterior:**

- Protect from physical damage
- Paint if desired (identification)
- Guard from vehicles if required
- Minimum height above grade

**Underground (coated steel):**

- Coating systems
- Wrapping
- Cathodic protection for larger systems
- Typically use PE pipe instead

### Expansion and Flexibility

**Thermal Expansion:**

- Pipe expands/contracts with temperature
- 100 ft of steel pipe expands 1" over 100°F change
- Allow for movement in long runs

**Methods:**

- Loops or offsets
- Expansion joints (commercial)
- Flexible sections
- Proper support allows sliding

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## 6.4 CSST Installation

Corrugated Stainless Steel Tubing requires specific installation practices.

### Manufacturer Requirements

**Critical:** Follow manufacturer instructions exactly

- Each manufacturer has specific requirements

- Use only manufacturer's fittings
- Use manufacturer sizing charts
- Installation variations between brands
- Certification may be required

## System Design

### Manifold System:

- Central manifold near gas meter
- Individual CSST runs to each appliance
- "Home run" configuration
- Minimizes fittings
- Easy to trace

### Trunk and Branch:

- Main CSST line (trunk)
- Branches to appliances
- More fittings
- More complex

## Installation Steps

### 1. Planning:

- Measure runs carefully
- Add length for routing
- Select proper CSST size
- Account for fittings
- Plan support locations

### 2. Cutting CSST:

- Use proper CSST cutter (not hacksaw)
- Cut square
- Don't crush tubing
- Remove burrs if any

### 3. Installing Fittings:

- Use manufacturer's striker tool
- Insert CSST fully into fitting
- Strike/crimp per instructions
- Verify proper engagement
- Visual inspection

**4. Routing:**

- Avoid sharp bends
- Minimum bend radius per manufacturer
- Protect from damage
- Support properly
- Keep accessible where possible

**5. Support:**

- Spacing per manufacturer (typically 4-6 ft horizontal)
- Use proper support clips/hangers
- Don't over-tighten
- Allow for movement
- Each floor level (vertical)

**6. Protection:**

- Protect from physical damage
- Can run through walls if jacketed
- Steel plates if near surface
- Cannot contact sharp edges
- Guard from abrasion

**7. Bonding:**

- **REQUIRED per CSA B149.1 Clause 7.11**
- Bonding clamp at CSST entry to structure
- #6 AWG copper conductor minimum
- Connect to electrical grounding system
- Electrician may be required
- Document bonding installation

## Bonding and Grounding (Critical)

**Why Required:**

- Lightning strike protection
- Electrical fault protection
- Prevents arcing through CSST wall
- Arc can rupture CSST causing gas release

**Bonding Requirements:**

**Clamp Location:**

- First fitting where CSST enters structure
- On rigid piping before CSST
- Listed bonding clamp

**Bonding Conductor:**

- Minimum #6 AWG copper
- Connect to electrical grounding electrode system
- May connect to electrical panel ground
- Follow electrical code
- Electrician typically performs

**Testing:**

- Verify bonding connection
- Check continuity
- Proper clamp installation
- Document

**Inspection:**

- Required by code
- Verify bonding present
- Failed inspection if not bonded

### CSST Sizing

**Use Manufacturer Tables:**

- Different from steel pipe tables
- Based on CSST diameter designation
- Consider pressure drop
- Account for fittings

**Example Sizing:**

- Appliance: 100,000 BTU/hr
- Run length: 50 ft
- Natural gas
- Manufacturer table indicates: 3/4" CSST

**Don't assume same size as steel pipe equivalent**

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# 6.5 Polyethylene Pipe Installation

PE pipe is standard for underground gas service lines.

## Material Selection

### PE 2708 or PE 4710:

- Yellow jacket (gas service)
- Pressure rating adequate for application
- SDR 11 common (Standard Dimension Ratio)
- Size marking on pipe

### Tracer Wire:

- Copper wire
- Locatable by wire locator
- Run alongside or attached to pipe
- Brought to surface at access points

## Fusion Joining

### Heat Fusion is ONLY Approved Method:

### Butt Fusion (Pipe to Pipe):

1. Square pipe ends
2. Heat fusion plate to proper temperature
3. Heat both pipe ends
4. Remove plate, join pipes
5. Hold until cooled
6. Proper bead formation indicates good fusion

### Socket Fusion (Pipe to Fitting):

1. Insert pipe into heated socket fitting
2. Hold until cooled
3. Verify proper depth

### Electrofusion:

- Special fittings with built-in heating element
- Electrical power melts fitting to pipe
- Indicator shows complete fusion
- More expensive but reliable

### Critical Factors:

- Proper temperature
- Clean surfaces (scrape oxidation)
- Proper heating time
- Proper cooling time (don't disturb)
- Visual inspection of bead

## Underground Installation

**Trenching:**

- Minimum depth per code (typically 18" below frost line)
- Width adequate for bedding and backfill
- Locate other utilities
- Shore if required (depth over 4 ft)

**Bedding:**

- 4-6" sand or fine soil
- Level bottom
- No rocks or sharp objects
- Uniform support

**Pipe Installation:**

- Lay pipe on bedding
- No tension (slight snake pattern)
- Allows for expansion/contraction
- Attach tracer wire
- Bring tracer wire to surface at terminations

**Backfill:**

- 6-12" clean fill over pipe first
- Hand compact gently
- Protects pipe from rocks
- No heavy equipment over pipe until adequate cover
- Verify no damage during backfill

**Marking:**

- Warning tape 12" above pipe
- "Caution Gas Line Below"
- Bright yellow
- Continuous over pipe route

## Transition to Steel

**Requirements:**

- Minimum 12" above grade
- Accessible for inspection
- Proper transition fitting
- No stress on connection
- Support both PE and steel

**Transition Fittings:**

- Compression fitting to PE
- NPT threads to steel
- Listed for purpose
- Proper installation

**Protection:**

- Guard from damage
- Identify as gas line
- Paint yellow (identification)
- Support steel pipe

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# 6.6 Above-Ground Piping

## Indoor Installation

**General Requirements:**

- Accessible for inspection
- Protected from damage
- Proper support
- Identified where required
- No conflicts with other trades

**Routing:**

- Neat and workmanlike
- Minimize fittings
- Adequate clearances
- Away from heat sources
- Consider appearance

**Concealed Piping:**

- Allowed in walls, ceilings, floors
- Must be continuous (no fittings in concealed spaces preferred)
- Accessible at appliances
- Test before concealing

**Identification:**

- Not required in dwellings (single family)
- Required in multi-residential and commercial
- Yellow paint or yellow marking
- "Gas" or "Fuel Gas"

### Outdoor Installation

**Protection:**

- Paint or coat (rust prevention)
- Support adequately
- Protect from physical damage
- Guard from vehicles if required
- Not in direct soil contact

**Clearances:**

- From buildings per code
- From other utilities
- From ignition sources
- Minimum height above grade

**Corrosion Prevention:**

- Paint (if desired)
- Coating systems
- Proper drainage (no water pockets)
- Inspect regularly

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# 6.7 Piping Through Structures

### Penetrations

**Through Walls and Floors:**

**Steel Pipe:**

- Can pass directly through
- Sleeve recommended (protection and access)
- No tight contact with structure
- Allow for expansion

**CSST:**

- Can pass through if jacketed
- Use proper sleeve/grommet
- Protect from abrasion
- No sharp edges

**PE Pipe:**

- Underground only
- Transition to steel above grade before penetration

**Sleeves:**

- Larger than pipe
- Sealed at one end (exterior)
- Open at interior (allows leak detection)
- Proper size for pipe plus expansion

## Clearances

**From Electrical:**

- Minimum separation per code
- Typically 6" from electrical panels
- Adequate separation from conduit
- CSST bonding addresses this

**From Other Utilities:**

- Adequate clearance
- No interference
- Identify all piping
- Coordinate with other trades

**From Heat Sources:**

- Adequate distance from flues
- Away from heat-producing equipment
- Consider radiant heat
- May require insulation or shields

# Chapter Summary

Gas piping materials include black steel (most common indoors), CSST (flexible alternative), polyethylene (underground), and copper tubing (limited use). Material selection depends on application, location, and local requirements. Each material has specific installation requirements and limitations.

Proper pipe sizing uses CSA B149.1 tables based on gas demand (BTU/hr converted to CFH), pipe length, allowable pressure drop, and specific gravity. The longest run method sizes entire system for worst case; branch length method optimizes each section. Equivalent length must be added for fittings.

Black steel installation requires proper threading to NPT standards, pipe joint compound on male threads only, adequate support spacing, and protection from damage. CSST installation requires manufacturer-specific procedures, proper fittings and tools, adequate support, and CRITICAL bonding per CSA B149.1 Clause 7.11.

Polyethylene pipe for underground use requires heat fusion joining, proper trenching and bedding, tracer wire, and transition to steel above grade. All piping must be tested per CSA B149.1 before placing in service.

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# Review Questions

## Multiple Choice

1. Which material is NOT approved for gas piping?
    - a) Black steel pipe
    - b) Galvanized steel pipe
    - c) CSST
    - d) Polyethylene pipe
2. Pipe joint compound should be applied to:
    - a) Female threads only
    - b) Male threads only
    - c) Both male and female threads
    - d) No threads (use Teflon tape only)
3. The maximum support spacing for 3/4" steel pipe installed horizontally is:
    - a) 4 feet
    - b) 6 feet
    - c) 8 feet
    - d) 10 feet
4. CSST must be bonded per CSA B149.1 using minimum:

    - a) #10 AWG copper
    - b) #8 AWG copper
    - c) #6 AWG copper
    - d) #4 AWG copper
5. Polyethylene pipe for gas service must be:
    - a) White
    - b) Black
    - c) Orange
    - d) Yellow
6. When sizing pipe using CSA B149.1 tables, the total appliance load should be converted to:
    - a) PSI
    - b) Cubic feet per hour (CFH)
    - c) Gallons per hour
    - d) Inches of water column
7. NPT pipe threads taper:
    - a) 1/4" per foot
    - b) 1/2" per foot
    - c) 3/4" per foot
    - d) 1" per foot
8. PE pipe joints must be made using:
    - a) Threaded connections
    - b) Compression fittings
    - c) Heat fusion
    - d) Glued joints
9. The minimum depth for underground PE gas pipe (below frost line) is typically:
    - a) 6 inches
    - b) 12 inches
    - c) 18 inches
    - d) 24 inches
10. CSST is primarily used for:
    - a) Underground installations
    - b) Indoor installations
    - c) High-pressure transmission
    - d) Water service lines

## True or False

11. Galvanized steel pipe can be used for gas piping if it's new pipe.
12. CSST can be buried underground for service lines.
13. Propane requires larger pipe than natural gas for the same BTU/hr load.
14. Tracer wire must be installed with underground PE gas pipe.
15. Flexible appliance connectors can pass through walls if properly supported.

## Short Answer

16. Explain why galvanized pipe is not permitted for gas piping. (3 marks)
17. List four advantages of CSST compared to black steel pipe. (4 marks)
18. Why must pipe joint compound be applied only to male threads and not female threads? (3 marks)
19. What is the purpose of bonding CSST systems, and what are the minimum bonding requirements? (5 marks)
20. Describe the proper procedure for transitioning from underground PE pipe to above-ground steel pipe. (4 marks)

### Long Answer

21. You need to size gas piping for a residential natural gas installation with the following:
    - Furnace: 100,000 BTU/hr
    - Water heater: 40,000 BTU/hr
    - Range: 65,000 BTU/hr
    - Longest run from meter: 55 feet
    - Supply pressure: 7" W.C.
    - Allowable pressure drop: 0.5" W.C.

    Show all calculations and determine the required pipe size using the longest run method. (10 marks)

22. Describe the complete procedure for installing black steel gas pipe, from cutting and threading through final assembly. Include:
    - Threading requirements
    - Pipe joint compound application
    - Assembly procedure
    - Support requirements
    - Protection requirements (12 marks)
23. Compare CSST and black steel pipe for residential gas piping. Include:
    - Material characteristics
    - Installation procedures
    - Advantages and disadvantages of each
    - Cost considerations
    - Code requirements specific to each
    - When you would choose one over the other (15 marks)

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# Practical Exercises

### Exercise 1: Pipe Threading Practice

Thread various sizes of pipe:

1. Cut pipe to specified length

2. Ream inside burr
3. Thread to proper length
4. Inspect threads for quality
5. Test-fit in coupling
6. Measure thread length
7. Document quality

## Exercise 2: Pipe Sizing Calculations

Using CSA B149.1 tables, size piping for:

1. Given appliance loads
2. Measured pipe lengths
3. Specified pressure drops
4. Both natural gas and propane
5. Document all calculations
6. Justify pipe size selections

## Exercise 3: System Layout Design

Design complete gas piping system:

1. Draw floor plan with appliance locations
2. Plan pipe routing
3. Measure all sections
4. Size each section
5. Calculate equivalent length with fittings
6. Prepare material list
7. Create installation drawing

## Exercise 4: CSST Installation

Install CSST practice system:

1. Measure and cut CSST
2. Install fittings using striker tool
3. Route and support properly
4. Install bonding per code
5. Pressure test system
6. Document installation

## Exercise 5: Pipe Assembly

Assemble gas piping system:

1. Thread all connections

2. Apply pipe dope correctly
3. Assemble system
4. Install supports
5. Verify all joints tight
6. Pressure test
7. Check for leaks

### Exercise 6: PE Pipe Fusion

Practice PE pipe fusion:

1. Square cut pipe ends
2. Scrape oxidation
3. Heat fusion machine to proper temperature
4. Heat pipe ends
5. Join pipes
6. Verify proper bead formation
7. Test joint strength

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# Case Studies

## Case Study 1: Undersized Piping

**Scenario:** A customer complains that when they turn on their gas dryer while the furnace is running, the furnace flames get very small and the furnace shuts down on limit. You measure gas pressure at the furnace and find it drops from 7" W.C. to 3" W.C. when the dryer starts. The system has 1/2" pipe for 80 feet from the meter.

**Questions:**

1. What is causing this problem?
2. Why does the furnace shut down?
3. Is 3" W.C. adequate for the furnace?
4. What pressure drop has occurred?
5. How would you verify the pipe is undersized?
6. What size pipe should have been installed?
7. What are the correction options?
8. How do you prevent this on future installations?

## Case Study 2: CSST Without Bonding

**Scenario:** During an inspection, you discover a 3-year-old CSST installation with no bonding to the electrical ground system. The system appears otherwise properly installed. The homeowner says there's never been a problem.

**Questions:**

1. Is this a code violation?
2. What is the safety risk?
3. Can the system remain in service?
4. Who is responsible for correction?
5. How should it be corrected?
6. What if the homeowner refuses to correct it?
7. What documentation is required?
8. Could insurance be affected?

## Case Study 3: Wrong Pipe Compound

**Scenario:** A recent gas piping installation is experiencing multiple leaks at threaded joints. Upon investigation, you find the installer used general-purpose Teflon tape without pipe dope, and applied it to both male and female threads. Some joints are also under-tightened.

**Questions:**

1. What are the problems with this installation?
2. Why is Teflon tape alone inadequate?
3. What's wrong with applying sealant to female threads?
4. How should joints have been sealed?
5. How tight should joints be?
6. What correction is required?
7. What testing is needed after correction?
8. What training does the installer need?

## Case Study 4: PE Pipe Installation Error

**Scenario:** During inspection of an underground gas line installation, you find PE pipe installed with compression fittings instead of heat fusion. The installer says "compression fittings are approved for water, so they should work for gas too."

**Questions:**

1. Is this installation acceptable?
2. What is the proper joining method for PE gas pipe?
3. Why are compression fittings not acceptable?
4. What are the risks of this installation?
5. Can any of the installed pipe be salvaged?
6. What is the proper correction?

7. What testing is required?
8. What notification to authorities is required?

### Case Study 5: Pipe Size Calculation Error

**Scenario:** You're reviewing plans for a gas installation. The designer sized the piping for the furnace (100,000 BTU) and water heater (40,000 BTU) but didn't include the range (65,000 BTU) or dryer (35,000 BTU) in the calculations. The piping is sized as 3/4" for the entire 45-foot run from meter.

**Questions:**

1. What is the error in the design?
2. What is the total system demand?
3. Is 3/4" pipe adequate for this installation?
4. What size should be used?
5. What would happen with the undersized pipe?
6. How would you explain this to the customer?
7. What is the cost impact of the correct sizing?
8. What if the piping is already installed?

### Case Study 6: Mixed Materials

**Scenario:** You find an installation where galvanized pipe was used for the first 10 feet from the meter, then transitioned to black pipe for the remainder of the system. The installer thought galvanized was "better" near the meter because it's outdoors.

**Questions:**

1. Is this installation compliant with CSA B149.1?
2. What problems does galvanized pipe cause?
3. When are the problems likely to manifest?
4. What correction is required?
5. Can the black pipe portion be retained?
6. What if galvanized shows no problems currently?
7. How do you explain this to the property owner?
8. What are the liability implications?

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# Key Terms

**Branch Length Method:** Pipe sizing method that sizes each section based on its specific load and length.

**CSST (Corrugated Stainless Steel Tubing):** Flexible stainless steel tubing for gas piping, requires bonding.

**Equivalent Length:** Additional length added to account for friction in fittings.

**Heat Fusion:** Joining method for polyethylene pipe using heat to melt and fuse pipe together.

**Longest Run Method:** Pipe sizing method using longest distance from meter to appliance for entire system.

**NPT (National Pipe Taper):** Standard tapered thread for pipe, seals on taper.

**PE Pipe (Polyethylene):** Plastic pipe approved for underground gas piping, must be yellow.

**Pipe Joint Compound (Pipe Dope):** Sealant applied to male threads for gas-tight joints.

**SDR (Standard Dimension Ratio):** Ratio of pipe diameter to wall thickness for PE pipe.

**Specific Gravity (SG):** Weight of gas compared to equal volume of air (natural gas 0.60, propane 1.52).

**Tracer Wire:** Copper wire installed with PE pipe to allow electronic locating.

**Water Column (W.C.):** Pressure measurement unit; inches of water column height.

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**End of Chapter 6**