Canadian Gas Technician G3 Learning Module 6

Gas Piping Materials and Methods

A comprehensive guide to approved piping materials, sizing calculations, and installation techniques for natural gas and propane systems in compliance with CSA B149.1

Learning Objectives

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

01

Identify approved piping materials for natural gas and propane installations

02

Select appropriate piping materials for different applications

03

Calculate pipe sizes using CSA B149.1 sizing tables

04

Apply pressure drop calculations for gas piping systems

05

Install black steel pipe with proper threading and joint compound

01

Install corrugated stainless steel tubing (CSST) per manufacturer specifications

02

Install polyethylene (PE) pipe for underground applications

03

Understand support spacing and protection requirements

04

Apply proper bonding and grounding for CSST systems

05

Install gas piping in compliance with CSA B149.1 requirements

Section 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)

Black Steel Pipe Sizes and Applications

Sizes:

- 1/8" through 12" (larger for commercial/industrial)
- Residential typically 1/2" through 1-1/4"
- Nominal sizes (not actual dimensions)

Applications:

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

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

Why Not Galvanized Steel?

Galvanizing (zinc coating) flakes off over time

Flakes can plug orifices, damage regulators

Prohibited by CSA B149.1

Black pipe only for gas

Critical Safety Point: Never use galvanized steel pipe for gas installations. The zinc coating deteriorates and creates dangerous blockages in gas system components.

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.)

CSST Sizes and Characteristics

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

CSST Installation Requirements

1

Follow manufacturer's instructions exactly

Use manufacturer's fittings only

2

Support per manufacturer specifications

Typically 4-6 ft spacing required

3

Protect from physical damage

Cannot contact sharp edges

4

MUST be bonded per CSA B149.1 Clause 7.11

Critical safety requirement

5

Cannot be buried underground (in most cases)

Jacketed CSST may be run through walls

CSST Bonding and Grounding

Critical Safety Requirement

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

Warning: Failure to properly bond CSST can result in catastrophic gas release if lightning strikes or electrical faults occur.

CSST Applications

Residential installations

Ideal for single-family homes where flexibility and speed of installation are valued

Light commercial

Suitable for small commercial applications with moderate gas demands

Retrofit installations

Easier routing through existing structures without major demolition

Where flexibility needed

Indoor installations primarily, especially in tight spaces or complex routing

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

PE Pipe Advantages and Disadvantages

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)

PE Pipe Installation Requirements

Yellow jacket (gas identification)

Clearly identifies pipe as gas service

Minimum depth per code

Typically 18" below frost line

Sand bedding if rocky soil

Protected from sharp objects

Tracer wire (copper) for locating

Essential for future location of non-metallic pipe

Transition to steel minimum 12" above grade

Cannot be threaded (heat fusion only)

Test per code requirements

Pressure testing before backfilling

Heat Fusion Methods for PE Pipe

Butt Fusion

Pipe to pipe connections using heated plate to melt and join ends

Socket Fusion

Pipe to fitting connections using heated socket

Electrofusion

Fitting with built-in heater element powered electrically

Critical Factors: Proper temperature and time are critical for successful fusion. Visual inspection of bead formation required. Training and certification recommended for all fusion work.

PE Pipe 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

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

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 use prohibited

Copper soft solder joints

Solder melts at low temperature

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

Must be CSA certified

Section 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 Factors Affecting Pipe Size

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

Converting BTU/hr to Cubic Feet per Hour

Step 3: Convert to Cubic Feet per Hour

For Natural Gas (1,000 BTU/ft³):

$$CFH = \frac{BTU/hr}{1,000}$$

$$CFH = \frac{240,000}{1,000} = 240 \text{ CFH}$$

For Propane (2,500 BTU/ft³):

$$CFH = \frac{BTU/hr}{2,500}$$

$$CFH = \frac{240,000}{2,500} = 96 \text{ CFH}$$

Important: Always use the correct heating value for the gas type. Natural gas and propane have significantly different energy content per cubic foot.

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

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.

Longest Run Method 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

Longest Run Method: Pros and Cons

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:

01

Draw System

Sketch piping layout. Mark all appliances. Measure each section length.

02

Calculate Section Loads

Start at farthest appliance. Work back toward meter. Each section carries load of all appliances downstream.

03

Size Each Section

Use appropriate length and load. May have different sizes in different sections.

Branch Length Method 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)
```

Branch Length Method: 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

Branch Length Method: Complete Sizing

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)

Branch Length Method: Revised Sizing

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

Branch Length Method: Pros and Cons

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
Plug valve	3 ft

Equivalent Length 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

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

62 ft

Total equivalent length:

40 + 9 + 10 + 3 = 62 ft

Specific Gravity Corrections

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

Correction Factor:

$$CF = \sqrt{\frac{\text{Table SG}}{\text{Actual SG}}}$$

Example:

Natural gas table based on 0.60 SG

Actual gas has 0.65 SG

$$CF = \sqrt{\frac{0.60}{0.65}} = \sqrt{0.923} = 0.96$$

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.

Section 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)

01

Cut pipe square

02

Ream inside burr

03

Secure in vise

04

Apply threading oil generously

05

Start die square to pipe

06

Thread to proper length

07

Back off periodically to break chips

08

Add oil continuously

09

Inspect threads

Thread Length Requirements

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)

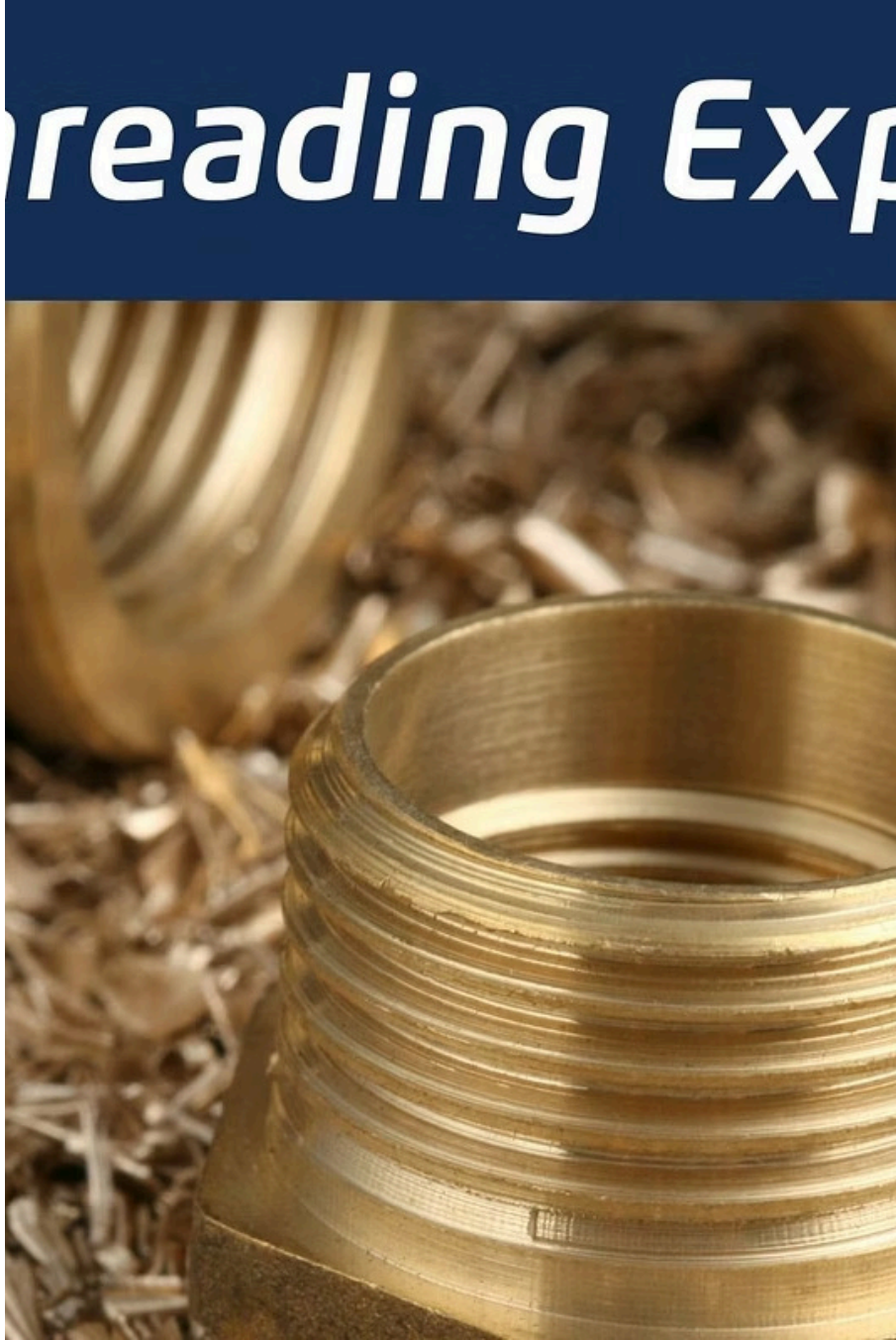
Too little: Won't engage properly, weak joint

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

Pipe Joint Compound 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

Critical requirement

Why only male threads:

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

Pipe Assembly Procedure

01

Apply compound to male threads

02

Start fitting by hand

Should thread easily

03

Tighten with wrenches

Wrench on fitting, wrench on pipe. Turn fitting, hold pipe.

04

Tighten until firm

Typically 2-3 turns past hand tight. Not excessive force. Fitting should not turn easily. Don't crack fitting.

Common Pipe Assembly 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 and Installation

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

Section 6.4

CSST Installation

Corrugated Stainless Steel Tubing requires specific installation practices.

CSST 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

CSST 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

CSST Installation Steps

01

Planning

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

02

Cutting CSST

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

03

Installing Fittings

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

04

Routing

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

CSST Installation Steps (continued)

01

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).

02

Protection

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

03

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.

CSST 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

CSST Bonding Testing and Inspection

Testing:

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

Inspection:

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

Critical Safety Warning: CSST installations without proper bonding are extremely dangerous and will fail inspection. This is not optional.

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