

# CHAPTER 8

## Pressure Testing and Purging

---

### Learning Objectives

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

1. Explain the purpose and importance of pressure testing gas piping systems
  2. Apply CSA B149.1 test pressure requirements for different installation types
  3. Select appropriate test medium for various applications
  4. Perform pressure tests and interpret results correctly
  5. Calculate acceptable pressure drop over test duration
  6. Locate and repair leaks detected during testing
  7. Understand purging requirements and safety considerations
  8. Calculate purge volume for gas piping systems
  9. Execute safe outdoor and indoor purging procedures
  10. Document testing and purging per code requirements
- 

### 8.1 Purpose of Pressure Testing

Pressure testing verifies the integrity of gas piping systems before placing them in service.

#### Why Pressure Testing is Required

##### Safety:

- Detects leaks before introducing gas
- Prevents gas accumulation in structures
- Protects occupants and property
- Identifies workmanship defects
- Verifies system integrity

##### Code Compliance:

- Required by CSA B149.1 for all new installations
- Required for modifications and additions
- Required after repairs
- Inspection requirement

- Permits cannot be closed without test

**Quality Assurance:**

- Verifies proper installation
- Confirms material integrity
- Tests all joints and connections
- Identifies hidden problems
- Protects installer's reputation

**Legal Protection:**

- Documents system integrity
- Provides evidence of proper work
- Protects against liability
- Required for insurance
- Professional standard

**When Pressure Testing is Required****New Installations:**

- All new gas piping systems
- Before concealing any piping
- Before connecting appliances
- Before introducing gas

**Modifications:**

- Additions to existing systems
- Changes to piping configuration
- Replacement of sections
- May test new portion only or entire system

**Repairs:**

- After repairing leaks
- After replacing components
- After disturbing joints
- Verify repair successful

**Existing Systems:**

- When leak suspected
- As part of major service
- During renovations

- When required by authority
- 

## 8.2 CSA B149.1 Test Requirements

CSA B149.1 specifies test pressures, duration, and acceptance criteria.

### Test Pressure Requirements

#### Test Pressure Based on Operating Pressure:

CSA B149.1 specifies test pressure as multiple of maximum operating pressure (MOP):

#### For Operating Pressures:

Maximum Operating Pressure	Minimum Test Pressure
125 kPa (18 PSI) or less	1.5 times MOP, but not less than 10 kPa (1.5 PSI)
Over 125 kPa (18 PSI)	1.5 times MOP

#### Common Applications:

##### Low-Pressure Systems (Typical Residential):

- Operating pressure: 2 kPa (8" W.C. or 0.29 PSI)
- Minimum test pressure: 10 kPa (1.5 PSI or 41" W.C.)
- Common test pressure: 3.5 kPa (14" W.C. or 0.5 PSI)

##### Medium-Pressure Systems:

- Operating pressure: 2-35 kPa (0.29-5 PSI)
- Test pressure:  $1.5 \times$  operating pressure (minimum 10 kPa)

##### High-Pressure Systems:

- Operating pressure: above 35 kPa (5 PSI)
- Test pressure:  $1.5 \times$  operating pressure

#### Important Notes:

- **Never exceed pressure rating of any system component**
- Isolate or remove regulators if test pressure exceeds rating
- Check appliance shut-off valves - may not be rated for test pressure
- CSST systems have specific test pressure limitations
- Document actual test pressure used

## **Test Duration**

### **Minimum Test Duration per CSA B149.1:**

#### **Standard Test:**

- **Minimum 10 minutes** at test pressure
- Longer duration preferred (30-60 minutes typical)
- Extended test for large systems
- Observe for entire duration

#### **For Systems Over 10 m<sup>3</sup> (350 ft<sup>3</sup>):**

- May require extended duration
- Check current code edition
- Follow authority requirements
- Engineer may specify longer tests

#### **Practical Considerations:**

- Longer tests more reliable
- Temperature stabilization time
- Allows careful inspection
- Industry standard often 30 minutes minimum

## **Acceptable Pressure Drop**

### **Acceptance Criteria:**

#### **No Pressure Drop:** Ideal result

- Pressure remains constant
- System is tight
- No leaks present

#### **Allowable Pressure Drop:**

- CSA B149.1 specifies allowable drop based on:
  - Test pressure
  - System volume
  - Test duration
  - Temperature effects

#### **General Guideline:**

- **No discernible pressure drop on test gauge**

- Any noticeable drop requires investigation
- Even small drops may indicate leaks
- Zero drop is goal

**Factors Affecting Pressure:**

- Temperature changes (air expands/contracts)
- Gauge accuracy
- System volume
- Test medium
- Pressure stabilization time

**Temperature Compensation:**

- Temperature drop = pressure drop
- Allow system to stabilize before starting timing
- Shield from sun and weather
- Account for temperature in acceptance decision

**Example:**

- 10-minute test at 14" W.C.
  - Pressure drops to 13.8" W.C.
  - Drop = 0.2" W.C. (1.4%)
  - Investigation required - likely leak
- 

## 8.3 Test Medium Selection

The medium used for testing affects safety and effectiveness.

**Air Testing****Most Common Test Medium****Advantages:**

- Readily available (free)
- Safe (non-toxic)
- Compressible (stores energy for test)
- Detects small leaks
- No contamination

**Disadvantages:**

- Contains moisture
- Temperature sensitive
- Supports combustion (if gas mixed)
- Must be completely removed before purging with gas

#### **Equipment:**

- Air compressor
- Pressure regulator
- Test gauge
- Connection fittings
- Relief valve (for over-pressure protection)

#### **Precautions:**

- Never exceed system component ratings
- Monitor pressure continuously
- Verify all appliances isolated
- Allow pressure stabilization
- Account for temperature changes

### **Nitrogen Testing**

#### **Inert Gas Testing**

##### **Advantages:**

- Inert (won't support combustion)
- Dry (no moisture)
- More stable than air (less temperature sensitivity)
- Can remain in system during purging
- Professional standard

##### **Disadvantages:**

- Cost (cylinder rental and gas purchase)
- Requires regulator and equipment
- Cylinder handling
- Not readily available

##### **When to Use:**

- High-pressure tests
- Critical installations
- Where moisture concern
- When required by engineer or code

- Professional/commercial installations

**Equipment:**

- Nitrogen cylinder
- Two-stage regulator
- Test gauge
- Connection hoses
- Proper fittings

**Safety:**

- Nitrogen is asphyxiant
- Adequate ventilation required
- Never enter enclosed space with nitrogen
- Monitor oxygen levels
- Proper cylinder handling and storage

**Other Test Media****Inert Gases (Argon, Helium, CO<sub>2</sub>):**

- Used in special circumstances
- Similar to nitrogen
- More expensive
- Rarely needed for gas piping

**Natural Gas or Propane:**

- **NEVER use gas for initial testing of new piping**
- Only used for testing operational systems
- Leak testing with gas requires special precautions
- Electronic detection only
- Not pressure testing

**Water:**

- Not used for gas piping (causes corrosion)
- Difficult to remove completely
- Freezing concern
- Mentioned only to prohibit its use

---

## 8.4 Testing Procedures

Proper procedure ensures accurate results and safety.

## **Pre-Test Preparation**

### **System Preparation:**

1. **Verify Piping Complete:**
  - All joints made up
  - All plugs and caps installed
  - All branches capped or valved
  - System ready for service (except appliances)
2. **Inspect Visually:**
  - Check all joints
  - Verify pipe supports
  - Look for obvious defects
  - Ensure protection in place
3. **Isolate Appliances:**
  - Close appliance shut-off valves
  - Verify valves tight
  - Or cap appliance connections
  - Protect appliance controls from over-pressure
4. **Isolate or Remove Regulators:**
  - Most regulators not rated for test pressure
  - Remove or isolate with valves
  - If testing through regulator, verify rating
  - Plan for regulator installation after test
5. **Install Test Equipment:**
  - Test gauge (accurate, readable)
  - Connection point (test tee or valve)
  - Pressure source connection
  - Relief valve (safety)
6. **Verify Gauge:**
  - Accurate and calibrated
  - Appropriate range for test pressure
  - Easy to read
  - Note starting pressure (atmospheric)

## **Test Execution**

### **Step-by-Step Procedure:**

#### **1. Pressurize System Slowly:**

- Apply pressure gradually
- Monitor all visible piping
- Listen for leaks



- Stop at test pressure
- Don't over-pressurize

## **2. Stabilization Period:**

- Allow 5-10 minutes for stabilization
- Pressure may fluctuate initially
- Temperature equalization
- Compression settling
- Adjust to test pressure after stabilization

## **3. Mark Starting Pressure and Time:**

- Note exact pressure
- Record time
- Note temperature if possible
- Start test duration timer

## **4. Monitor Throughout Test:**

- Observe gauge continuously or frequently
- Watch for pressure drop
- Note any changes
- Listen for leaks
- Check visible joints

## **5. Record Final Pressure:**

- Note pressure at end of test period
- Calculate pressure drop
- Note temperature change
- Document conditions

## **6. Evaluate Results:**

- Compare to acceptance criteria
- Investigate any pressure drop
- Determine pass/fail

## **Leak Detection During Testing**

### **If Pressure Drop Detected:**

#### **1. Soap Solution Method:**

- Most effective for pinpointing leaks

- Apply to all joints systematically
- Bubbles indicate leak
- Mark leaks for repair
- Start at highest suspected points

## **2. Listen:**

- Larger leaks audible
- Quiet environment helpful
- May hear hissing
- Follow sound to source

## **3. Electronic Detection:**

- Combustible gas detector can detect compressed air in some cases
- Ultrasonic leak detectors (professional)
- Follow manufacturer instructions

## **4. Isolate Sections:**

- If large system, isolate branches
- Test sections individually
- Narrow down leak location
- Systematic approach

## **5. Common Leak Locations:**

- Threaded joints (most common)
- Unions
- Valves
- Caps and plugs
- Damage during installation
- Fittings

## **Repairing Leaks**

### **Repair Procedure:**

- 1. Release Test Pressure:**
  - Depressurize system slowly
  - Vent to atmosphere safely
  - Ensure zero pressure before opening joints
- 2. Repair Leak:**
  - Threaded joint: Re-make with fresh compound
  - Damaged pipe/fitting: Replace section
  - CSST: Re-strike fitting or replace

- Verify cause of leak
- 3. **Re-Test:**
  - Pressurize system again
  - Full test duration
  - Verify repair successful
  - May need multiple test cycles

**Do Not:**

- Attempt to tighten pressurized joints (dangerous)
- Apply sealant to pressurized joints
- Ignore small leaks
- Accept marginal results

**Passing the Test**

**Acceptance:**

- Pressure stable over test duration
- No discernible drop on gauge
- No leaks detected with soap solution
- All joints tight
- System ready for service

**Documentation:**

- Record test pressure
- Record test duration
- Record start and end pressure
- Note temperature
- Sign and date
- Provide copy to customer and inspector
- Retain in records

**Failed Test**

**If Test Fails:**

1. Do NOT put system in service
2. Locate and repair all leaks
3. Re-test entire system
4. Document repairs
5. Notify customer of delays
6. Don't conceal piping until passed

**Common Reasons for Failure:**

- Insufficient pipe dope
  - Cross-threaded fittings
  - Damaged threads
  - Loose joints
  - Damaged piping
  - Poor workmanship
- 

## **8.5 Special Testing Considerations**

Different piping materials and situations require specific procedures.

### **Testing CSST Systems**

#### **Manufacturer Requirements:**

- Follow manufacturer specifications exactly
- Maximum test pressure limits
- Some CSST limited to 15-20 PSI test pressure
- Do not exceed manufacturer maximum

#### **Procedure:**

- Lower test pressure acceptable if meets code minimum
- Extended duration may be required
- Visual inspection critical
- All fittings must be properly struck/crimped

#### **Bonding:**

- Verify bonding installed before test
- Test bonding continuity
- Document bonding compliance

### **Testing PE Pipe**

#### **Underground PE Piping:**

##### **Test Pressure:**

- Follow CSA B149.1 requirements
- $1.5 \times$  operating pressure minimum
- Typically 10 PSI or higher

**Duration:**

- Minimum 10 minutes
- 30-60 minutes recommended
- Allow stabilization time

**Considerations:**

- PE pipe is flexible - expands under pressure
- Longer stabilization time
- Temperature effects significant
- May show initial pressure drop (normal)
- Wait for stabilization before starting timer

**Transition Points:**

- Pay special attention to PE-to-steel transitions
- Common leak location
- Soap test thoroughly

**Testing Existing Systems****Partial System Testing:**

- May test new addition only
- Isolate new from existing with valve
- Or test entire system
- Code requires testing modified portions

**Lower Test Pressure:**

- Existing systems may have appliances connected
- May not be practical to isolate all appliances
- Can use lower test pressure if needed
- 3" W.C. (0.1 PSI) minimum with soap test
- Not as effective as proper pressure test

**Operational Testing:**

- With gas in system
  - Using electronic detector or soap
  - Start at meter and work downstream
  - Check every joint
  - Lower confidence than pressure test
-

## 8.6 Purging Procedures

Purging removes air from gas piping before introducing gas to appliances.

### Purpose of Purging

#### Safety:

- Removes air from piping
- Prevents air-gas mixture (explosive)
- Ensures pure gas reaches appliances
- Required before appliance operation

#### Proper Appliance Operation:

- Air in system prevents ignition
- Appliances won't light with air
- Pilot lights difficult
- Main burners won't ignite

#### Code Requirement:

- CSA B149.1 requires purging
- Must purge completely before service
- Specific procedures required
- Documentation may be required

### Volume Calculation

#### System Volume:

Need to calculate volume of piping to determine purge time:

**Formula:**  $\text{Volume} = \pi \times r^2 \times L$

Where:

- $\pi = 3.14159$
- $r$  = inside radius of pipe
- $L$  = length of pipe

#### Easier Method - Use Table:

##### Pipe Size Volume per Foot

1/2"      0.0106 ft<sup>3</sup>/ft

**Pipe Size Volume per Foot**

3/4"	0.0233 ft <sup>3</sup> /ft
1"	0.0411 ft <sup>3</sup> /ft
1-1/4"	0.0647 ft <sup>3</sup> /ft
1-1/2"	0.0933 ft <sup>3</sup> /ft
2"	0.1632 ft <sup>3</sup> /ft

**Example Calculation:**

System:

- 50 ft of 3/4" pipe =  $50 \times 0.0233 = 1.165 \text{ ft}^3$
- 30 ft of 1/2" pipe =  $30 \times 0.0106 = 0.318 \text{ ft}^3$
- Total volume =  $1.165 + 0.318 = 1.483 \text{ ft}^3$

**Purge Volume Required:**

- Minimum 3 times system volume (CSA B149.1)
- Better: 4-5 times for complete purge
- Example:  $1.483 \times 3 = 4.45 \text{ ft}^3$  minimum
- Preferred:  $1.483 \times 4 = 5.93 \text{ ft}^3$

**Outdoor Purging****Safest and Preferred Method****When to Use:**

- New installations
- Large systems
- Whenever practical
- Where gas can be safely vented outside

**Procedure:****1. Preparation:**

- Verify test passed and pressure released
- Close all appliance valves
- Select purge point (farthest from gas source)
- Prepare to vent gas outdoors
- Eliminate ignition sources nearby

**2. Open Purge Point:**

- Remove cap or open valve at purge point
- Attach hose if needed to direct gas outside
- Minimum 3 m (10 ft) from ignition sources
- Away from building openings
- Adequate ventilation

### **3. Open Gas Supply:**

- Slowly open gas valve at meter/tank
- Gas flows through system
- Air pushed out purge point
- Monitor flow

### **4. Test for Gas:**

- Use combustible gas indicator at purge point
- Or use flame test (match or lighter at purge opening)
  - Blue flame = gas present
  - Yellow/orange flame = still air
- Continue until pure gas

### **5. Verify Volume:**

- Calculate time or volume
- Minimum 3× system volume
- Better to purge longer than minimum

### **6. Close Purge Point:**

- Close valve or reinstall cap
- Remove purge hose
- Test joint with soap solution

### **7. Pressurize System:**

- Allow pressure to build
- Check system pressure at meter
- Ready for appliance connection

## **Indoor Purging**

### **Only When Outdoor Purging Not Practical**

#### **Requirements:**

- Adequate ventilation critical



- Small volumes only
- Special provisions per code
- More hazardous than outdoor

**When Allowed:**

- Small additions to existing systems
- Very small system volumes
- Where outdoor purging impossible
- Follow code requirements strictly

**Procedure:**

**1. Ensure Adequate Ventilation:**

- Open windows and doors
- Mechanical ventilation if available
- Create air flow through space
- Monitor gas concentration
- Have combustible gas detector

**2. Eliminate Ignition Sources:**

- No smoking
- No open flames
- No pilot lights
- Electrical switches off
- Water heater pilots off
- Furnace pilots off

**3. Notify Occupants:**

- Building occupants must leave or be in safe area
- Post warning if needed
- Control access

**4. Purge Small Volumes:**

- Open purge point
- Open gas supply slowly
- Vent into room
- Monitor gas concentration
- Stop if concentration exceeds 25% LEL (1.25% for natural gas)
- Minimum volume required

**5. Ventilate After Purging:**

- Continue ventilation after purging complete
- Verify gas concentration drops to safe levels
- Allow adequate time
- Test with detector

## **6. Restore System:**

- Close purge point
- Re-light pilots
- System ready for service

## **Critical Safety:**

- Indoor purging is hazardous
- Must follow code exactly
- Emergency ventilation plan
- Gas detector required
- Trained personnel only

## **Purging with Inert Gas**

### **Inert Gas Pre-Purge:**

#### **When Used:**

- High-pressure systems
- Where air-gas mixture unacceptable
- Critical installations
- Where required by engineer

#### **Procedure:**

1. Pressure test with nitrogen (or other inert gas)
2. Leave nitrogen in system
3. Purge nitrogen with natural gas/propane
4. Reduces risk of explosive mixture
5. Never creates flammable mixture (nitrogen to gas)

#### **Advantages:**

- Safer (no air-gas mixture formed)
- Better for high-pressure systems
- Professional standard for critical applications

#### **Disadvantages:**

- Additional cost (nitrogen)
  - Additional time
  - Requires equipment
- 

## 8.7 Appliance Connection and Initial Lighting

After purging, appliances can be connected and lit.

### Connecting Appliances

#### Final Connections:

1. Remove caps from appliance branches
2. Connect appliances per manufacturer instructions
3. Use proper fittings and compounds
4. Flexible connectors where appropriate
5. Test all new connections with soap solution
6. Support piping properly

### Initial Appliance Lighting

#### Systematic Approach:

##### 1. Verify Gas Available:

- Check pressure at appliance
- Verify valve open
- Gas reaching appliance

##### 2. Light Pilots:

- Follow manufacturer lighting instructions
- Purge air from pilot line
- May take time for gas to reach pilot
- Bleed air at pilot connection if needed

##### 3. Test Main Burner:

- Call for heat/operation
- Verify ignition
- Check flame characteristics
- Adjust if needed

#### **4. Test All Safeties:**

- Verify controls operate
- Test limit switches
- Verify pressure switches
- Check all interlocks

#### **5. Adjust and Fine-Tune:**

- Manifold pressure
- Primary air
- Flame characteristics
- Combustion testing

### **Documentation**

#### **Required Records:**

##### **Pressure Test:**

- Date and time
- Test pressure used
- Test duration
- Start and end pressure
- Pass/fail result
- Test medium used
- Technician name and license
- Inspector sign-off (if present)

##### **Purge:**

- System volume calculated
- Purge method (outdoor/indoor)
- Purge volume/time
- Verification method
- Date completed
- Technician name

##### **Appliance Commissioning:**

- Each appliance
- Pressure settings
- Combustion test results
- Adjustments made
- Date and technician

**Provide Copies:**

- Customer
  - Inspector/authority
  - Retain in company files
  - Required retention: typically 7 years
- 

## **8.8 Troubleshooting Test Problems**

### **Cannot Achieve Test Pressure**

**Symptoms:**

- Pressure builds slowly or not at all
- Gauge doesn't reach setpoint
- Compressor runs continuously

**Possible Causes:****1. Large Leak:**

- Major joint not made up
- Pipe damage
- Valve not closed
- Check: Listen for loud hissing
- Solution: Find and repair leak

**2. Inadequate Pressure Source:**

- Compressor too small
- Low inlet pressure
- Source not capable
- Check: Source gauge reading
- Solution: Larger compressor or higher pressure source

**3. Gauge Problem:**

- Incorrect gauge
- Broken gauge
- Wrong connection
- Check: Verify gauge with second gauge
- Solution: Replace or reconnect gauge

**4. System Too Large:**

- Volume exceeds source capacity
- Takes long time to pressurize
- Not actually a problem if eventually reaches pressure
- Solution: Patience, larger source, or section testing

## **Pressure Drops During Test**

### **Symptoms:**

- Pressure drops over test duration
- Fails acceptance criteria
- System leaking

### **Possible Causes:**

#### **1. Actual Leaks:**

- Most common cause
- Threaded joints
- Damaged piping
- Solution: Find and repair all leaks

#### **2. Temperature Drop:**

- Air cooling causes pressure drop
- Outdoor testing in changing weather
- Sun to shade
- Can be significant
- Check: Temperature of piping/ambient
- Solution: Account for temperature in evaluation

#### **3. Gauge Drift:**

- Gauge reading changing
- Gauge inaccuracy
- Check: Use multiple gauges
- Solution: Better gauge

#### **4. System Stabilization:**

- Piping expanding under pressure (PE pipe especially)
- Pressure settling
- Should stabilize after initial period
- Check: Wait longer before starting timer
- Solution: Allow adequate stabilization time

## **Pressure Rises During Test**

### **Symptoms:**

- Pressure increases over test duration
- Unexpected result

### **Possible Causes:**

#### **1. Temperature Rise:**

- Sun heating piping
- Ambient temperature increase
- Air expanding
- Most common cause
- Check: Temperature of piping
- Solution: Shield from sun, account for temperature

#### **2. Continued Pressurization:**

- Source still connected and flowing
- Relief valve not functioning
- Check: Isolate source
- Solution: Close source valve, check relief

#### **3. Gauge Error:**

- Gauge problem
- Reading incorrectly
- Check: Verify with second gauge
- Solution: Better gauge

---

## **Chapter Summary**

Pressure testing verifies the integrity of gas piping systems before introducing gas. CSA B149.1 requires testing at 1.5 times maximum operating pressure for minimum 10 minutes, with no discernible pressure drop. Typical residential test pressure is 14" W.C. (3.5 kPa), though 10 kPa is code minimum. Air is the most common test medium, with nitrogen providing advantages for critical or high-pressure applications.

Testing procedure includes system preparation, gradual pressurization, stabilization period, monitoring throughout test duration, and documentation of results. Any pressure drop requires investigation and leak repair using soap solution, systematic inspection, or isolation techniques.

Special considerations apply to CSST (manufacturer pressure limits) and PE pipe (extended stabilization time).

Purging removes air from piping before gas introduction, requiring minimum three times system volume per CSA B149.1. Outdoor purging is preferred and safest; indoor purging requires special precautions and adequate ventilation. Volume calculations determine purge time, verified by gas detection or flame test at purge point.

Complete documentation includes test pressure, duration, results, purge method and volume, and appliance commissioning data. Proper testing and purging procedures ensure safe installations, code compliance, and system integrity for the life of the installation.

---

## Review Questions

### Multiple Choice

1. According to CSA B149.1, the minimum test pressure for a system with operating pressure under 18 PSI is:
  - a) 1.5 PSI
  - b) 3.5 kPa (14" W.C.)
  - c) 10 kPa (41" W.C.)
  - d) 15 PSI
2. The minimum test duration required by CSA B149.1 is:
  - a) 5 minutes
  - b) 10 minutes
  - c) 30 minutes
  - d) 60 minutes
3. The minimum purge volume required is:
  - a) Equal to system volume
  - b) Twice system volume
  - c) Three times system volume
  - d) Five times system volume
4. When purging indoors, gas concentration should not exceed:
  - a) 10% LEL
  - b) 25% LEL
  - c) 50% LEL
  - d) 100% LEL
5. The most common test medium for residential gas piping is:
  - a) Natural gas
  - b) Propane
  - c) Nitrogen
  - d) Air
6. If a test shows pressure drop, the first step is to:
  - a) Pass the test anyway



- b) Use soap solution to find leaks
  - c) Reduce test pressure
  - d) Ignore small drops
7. Outdoor purging should direct gas at least \_\_\_\_\_ from ignition sources:
- a) 1 m (3 ft)
  - b) 3 m (10 ft)
  - c) 5 m (15 ft)
  - d) 10 m (30 ft)
8. During pressure testing, regulators should be:
- a) Left in place always
  - b) Adjusted to maximum
  - c) Isolated or removed if test pressure exceeds rating
  - d) Tested at same pressure as piping
9. Temperature drop during testing will cause pressure to:
- a) Increase
  - b) Decrease
  - c) Remain stable
  - d) Fluctuate randomly
10. After completing purging, before lighting appliances, you should:
- a) Wait 24 hours
  - b) Test all connections with soap solution
  - c) Increase pressure
  - d) Call for inspection

### True or False

- 11. Water can be used as a test medium for gas piping if below freezing temperatures.
- 12. Any pressure drop during testing, even small amounts, requires investigation.
- 13. Indoor purging is preferred over outdoor purging when practical.
- 14. CSST systems can always be tested at the same pressure as steel pipe.
- 15. Documentation of pressure testing is required for code compliance.

### Short Answer

- 16. Explain why pressure testing is performed before introducing gas to a new piping system. (4 marks)
- 17. List four factors that can cause pressure to drop during a test even if there are no leaks. (4 marks)
- 18. Why is outdoor purging preferred over indoor purging? (3 marks)
- 19. Describe how to verify that purging is complete and pure gas is present at the purge point. (4 marks)
- 20. Why must the test pressure not exceed manufacturer ratings for CSST systems? (3 marks)

### Long Answer

21. Describe the complete procedure for pressure testing a residential natural gas piping system. Include:
- Pre-test preparation and system isolation
  - Test pressure selection
  - Step-by-step testing procedure
  - Acceptable results criteria
  - Actions if test fails
  - Documentation requirements (15 marks)
22. Calculate the purge volume for the following system and describe the complete outdoor purging procedure:
- 40 feet of 3/4" pipe (0.0233 ft<sup>3</sup>/ft)
  - 25 feet of 1/2" pipe (0.0106 ft<sup>3</sup>/ft)
  - 15 feet of 1" pipe (0.0411 ft<sup>3</sup>/ft)

Include: - Volume calculations - Minimum purge volume (3× system volume) - Complete purging procedure - Verification method - Safety considerations (12 marks)

23. Compare air testing and nitrogen testing for gas piping systems. Include:
- Advantages and disadvantages of each
  - When each is appropriate
  - Safety considerations for each
  - Cost and equipment differences
  - Why nitrogen is preferred for critical applications
  - Which you would recommend for a typical residential installation and why (15 marks)
- 

## **Practical Exercises**

### **Exercise 1: Pressure Test Procedure**

On training system or actual installation:

1. Prepare system for testing
2. Install test gauge and equipment
3. Pressurize to test pressure
4. Allow stabilization
5. Monitor for test duration
6. Document results
7. Interpret pass/fail
8. Complete test documentation

### **Exercise 2: Leak Detection**

On system with known leak(s):

1. Perform pressure test
2. Detect pressure drop
3. Use soap solution systematically
4. Locate all leaks
5. Mark leak locations
6. Prioritize repairs
7. Plan correction strategy

### **Exercise 3: Volume Calculation**

Given system drawings:

1. Measure all pipe runs
2. Calculate volume of each section
3. Sum total system volume
4. Calculate required purge volume
5. Estimate purge time at typical flow rate
6. Document calculations

### **Exercise 4: Outdoor Purging**

On training system:

1. Calculate system volume
2. Set up purge point outdoors
3. Open gas supply
4. Monitor purge progress
5. Test for gas at purge point
6. Verify adequate volume purged
7. Close purge point
8. Test purge point connection
9. Document procedure

### **Exercise 5: Test Documentation**

Practice completing:

1. Pressure test report forms
2. Required information
3. Calculations
4. Pass/fail determination
5. Signature and license number
6. Customer copy
7. Regulatory copy

### **Exercise 6: Failed Test Response**

Simulate failed pressure test:

1. Identify pressure drop
  2. Develop systematic leak search plan
  3. Prioritize likely leak locations
  4. Execute search procedure
  5. Document findings
  6. Plan repairs
  7. Estimate time for correction
- 

## Case Studies

### Case Study 1: Persistent Small Leak

**Scenario:** You perform a pressure test on a new residential installation. Test pressure is 14" W.C. After 30 minutes, pressure has dropped to 13.5" W.C. (0.5" W.C. drop, 3.6%). You soap test all visible joints - no bubbles found anywhere. Temperature has been constant. The system has 60 feet of exposed piping and 40 feet concealed in walls.

#### Questions:

1. Is this test acceptable?
2. Where could the leak be?
3. How can you isolate the problem?
4. What if the leak is in concealed piping?
5. Can you section test to narrow down location?
6. What if you can't find the leak?
7. Can you put the system in service?
8. What do you tell the customer?

### Case Study 2: Temperature Effect

**Scenario:** You pressure test an outdoor gas line on a sunny morning. Initial pressure: 14.0" W.C. at 9:00 AM. You check after 20 minutes: 14.3" W.C. You wait another 10 minutes: 14.5" W.C. The pipe is in full sun and warm to the touch.

#### Questions:

1. Why is pressure increasing?
2. Is this acceptable?
3. How do you account for temperature effect?
4. Should you fail the test?
5. How can you minimize temperature effects?
6. What if clouds move in and temperature drops during test?

7. How do you determine if actual leaks present?
8. What do you document?

### **Case Study 3: CSST Pressure Limitation**

**Scenario:** You're installing a CSST system. The manufacturer specifies maximum test pressure of 15 PSI. Your standard residential test is 14" W.C. (0.5 PSI) which is well under 15 PSI. However, the inspector wants you to test at 3.5 PSI (96" W.C.) which exceeds manufacturer limit.

#### **Questions:**

1. What is the code minimum test pressure?
2. What is your standard test pressure?
3. Can you test at 3.5 PSI?
4. What does the manufacturer restriction mean?
5. How do you handle the inspector's request?
6. What test pressure should you use?
7. Who has authority - code, manufacturer, or inspector?
8. How do you document this situation?

### **Case Study 4: Indoor Purging Gone Wrong**

**Scenario:** An apprentice is adding a gas line for a dryer in a basement. The addition is 20 feet of 1/2" pipe (volume about 0.2 ft<sup>3</sup>). Instead of purging outdoors, he opens the gas valve in the basement "to save time." The water heater pilot light is still burning. Within seconds, you smell gas heavily and see the apprentice still at the open purge point.

#### **Questions:**

1. What immediate actions do you take?
2. What dangers exist?
3. What procedure violations occurred?
4. How should this have been done?
5. What if outdoor purging truly impossible?
6. What training does the apprentice need?
7. What safety protocols should be in place?
8. What if gas had ignited?

### **Case Study 5: Test Equipment Failure**

**Scenario:** You're performing a pressure test using your digital manometer. Initial pressure: 14.0" W.C. After 15 minutes: 13.7" W.C. You suspect a leak and start soap testing. Your assistant checks your gauge with his mechanical gauge - it shows 14.1" W.C. and is stable. You realize your digital gauge is drifting.

**Questions:**

1. What is the actual test result?
2. How do you verify gauge accuracy?
3. Can you complete test with suspect gauge?
4. What if you'd repaired joints based on faulty gauge?
5. How often should gauges be calibrated?
6. What backup equipment should you have?
7. How do you document this situation?
8. Can you trust any readings from this gauge today?

**Case Study 6: Incomplete Purge**

**Scenario:** You purge a new system outdoors. After what you think is adequate purging (you heard gas coming out), you close the purge point and light the furnace pilot. The pilot lights but immediately goes out. Several attempts fail. You check gas pressure at furnace - it's correct at 7" W.C.

**Questions:**

1. What is the most likely problem?
2. How do you verify air still in system?
3. Did you purge adequately?
4. How should purging be verified?
5. What is the proper correction?
6. How much should you have purged?
7. Can you purge through the appliance pilot line?
8. How do you prevent this in future?

**Case Study 7: Large System Test**

**Scenario:** You're testing a commercial system with 500 feet of 2" pipe, 300 feet of 1-1/4" pipe, and multiple branches. Your small air compressor cannot build pressure above 5" W.C. even after 30 minutes. The system needs to test at 14" W.C.

**Questions:**

1. Why can't you achieve test pressure?
2. What is the system volume (approximately)?
3. What size compressor/air source needed?
4. Can you section-test instead?
5. What are advantages of section testing?
6. What are disadvantages?
7. How do you document section testing?
8. What if you must test entire system at once?

---

## Key Terms

**Acceptable Pressure Drop:** Maximum pressure decrease allowed during test (generally zero for residential).

**Air Testing:** Using compressed air as test medium for pressure testing.

**Inert Gas:** Non-reactive gas such as nitrogen used for testing; won't support combustion.

**LEL (Lower Explosive Limit):** Minimum gas concentration that will ignite (natural gas 5%, propane 2.1%).

**Lock-Up Pressure:** Pressure in closed system with no flow; regulator testing term.

**Maximum Operating Pressure (MOP):** Highest pressure at which system normally operates.

**Nitrogen Testing:** Using nitrogen gas as test medium; professional standard for critical applications.

**Outdoor Purging:** Venting air/gas mixture outside building during purging; safest method.

**Pressure Drop:** Decrease in pressure during test; indicates leak if not due to temperature.

**Purging:** Process of removing air from gas piping by flowing gas through system.

**Soap Solution:** Mixture of water and soap for detecting gas leaks; creates bubbles at leak points.

**Stabilization Period:** Time allowed for pressure and temperature to equalize before starting test timing.

**System Volume:** Total internal volume of piping; determines purge volume required.

**Test Duration:** Time period pressure must be maintained during test (minimum 10 minutes per CSA B149.1).

**Test Medium:** Substance used for pressure testing (air, nitrogen, etc.).

**Test Pressure:** Pressure applied during test; typically  $1.5\times$  maximum operating pressure.