CHAPTER 12

Venting Systems

Learning Objectives

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

1. Explain the principles of natural draft and factors affecting venting performance
2. Select appropriate venting materials based on appliance category and application
3. Size venting systems according to CSA B149.1 requirements
4. Install Type B vent systems following code requirements
5. Configure direct vent and power vent systems properly
6. Design condensate management systems for high-efficiency appliances
7. Troubleshoot common venting problems and spillage issues
8. Perform draft measurements and interpret results
9. Identify unsafe venting conditions and implement corrections
10. Apply manufacturer specifications and code requirements for complex venting scenarios

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12.1 Venting Principles

Understanding venting principles is fundamental to safe gas appliance installation. Proper venting removes products of combustion from buildings while preventing spillage that could endanger occupants.

Natural Draft Operation

Natural draft relies on the buoyancy of hot combustion products to create flow through the venting system without mechanical assistance.

Physics of Natural Draft

Driving Forces:

- Temperature difference between flue gases and ambient air
- Density difference creates buoyancy
- Height of vent increases draft
- Chimney effect draws combustion products upward

Draft Equation:

```
Draft (inches W.C.) = 0.52 × H × (1/To - 1/Ti)
```

Where:

- H = Height of chimney in feet
- To = Outside absolute temperature (°R)
- Ti = Inside flue gas temperature (°R)
- °R = °F + 460

Example Calculation:

- Chimney height: 20 feet
- Outside temperature: 40°F (500°R)
- Flue gas temperature: 400°F (860°R)

```
Draft = 0.52 × 20 × (1/500 - 1/860)
Draft = 10.4 × (0.002 - 0.00116)
Draft = 10.4 × 0.00084
Draft = 0.0087" W.C.
```

Components of Natural Draft Systems

Draft Hood:

- Isolates burner from chimney conditions
- Provides secondary air
- Prevents backdraft from affecting burner
- Acts as relief opening
- Required on Category I appliances

Vent Connector:

- Pipe from appliance to chimney or vent
- Single wall or Type B
- Must maintain proper rise
- Limited length per code

Chimney or Vent:

- Vertical portion creating draft
- Type B vent or masonry chimney
- Must extend above roof
- Proper termination critical

Stack Effect

Stack effect is the movement of air through buildings due to temperature-induced density differences.

Mechanics of Stack Effect

Winter Conditions:

- Warm air inside rises
- Creates negative pressure at bottom
- Positive pressure at top
- Neutral pressure plane in middle
- Can assist or oppose venting

Summer Conditions:

- Often reversed from winter
- Air conditioning creates negative pressure
- Can increase spillage potential
- Reduced temperature differential
- Weaker natural draft

Building Influences

Factors Affecting Stack Effect:

1. **Building Height:**
    - Taller buildings = stronger stack effect
    - Pressure differential increases with height
    - High-rise considerations
2. **Temperature Differential:**
    - Greater difference = stronger effect
    - Seasonal variations
    - Climate considerations
3. **Air Leakage:**
    - Building tightness affects pressure
    - Weatherization impacts
    - Mechanical ventilation interference
4. **Neutral Pressure Plane:**
    - Divides positive/negative zones
    - Moves with conditions
    - Affects appliance location considerations

Available Draft

Available draft is the actual negative pressure created by the venting system under operating conditions.

Measuring Available Draft

Test Procedure:

1. Drill test hole in vent connector
2. 2 pipe diameters from draft hood
3. At least 6" before any elbow
4. Insert draft gauge probe
5. Operate appliance 5 minutes
6. Read draft in inches W.C.

Typical Draft Values:

Appliance Type	Normal Draft Range	Minimum Required
Natural Draft Water Heater	-0.02" to -0.04"	-0.01"
Natural Draft Furnace	-0.02" to -0.05"	-0.02"
Draft Hood Boiler	-0.03" to -0.06"	-0.02"
Atmospheric Burner	-0.02" to -0.04"	-0.01"

Factors Affecting Available Draft

Positive Factors (Increase Draft):

- Higher flue gas temperature
- Taller vent height
- Cold outdoor temperature
- Proper vent sizing
- Smooth vent interior

Negative Factors (Decrease Draft):

- Restrictions in vent
- Excessive elbows
- Horizontal runs
- Oversized venting
- Wind effects

Factors Affecting Draft

Multiple factors interact to determine venting system performance.

Temperature Effects

Flue Gas Temperature:

- Higher temperature = lower density
- Creates stronger buoyancy
- Affected by:
    - Input rate
    - Efficiency
    - Dilution air
    - Heat exchanger design

Ambient Temperature:

- Cold outdoor air increases draft
- Indoor/outdoor differential critical
- Seasonal variations significant
- Design for worst case (summer)

Temperature Profile in Vent:

- Cools as it rises
- Condensation potential
- Insulation effects
- Mass flow considerations

Physical Configuration

Height:

- Primary draft producer
- Minimum heights required
- Maximum heights limited
- Effective height calculations

Diameter:

- Must handle volume
- Too small = restriction
- Too large = poor velocity
- Proper sizing critical

Routing:

- Vertical preferred
- Offsets reduce draft
- Elbows add resistance
- Length limitations

Environmental Factors

Wind Effects:

- Can increase or decrease draft
- Direction dependent
- Termination design critical
- Wind caps may help

Atmospheric Pressure:

- Barometric changes
- Altitude effects
- Storm systems
- Generally minor influence

Building Conditions:

- Exhaust fans
- Clothes dryers
- Kitchen hoods
- Fireplaces
- Door/window position

Spillage and Backdrafting

Spillage occurs when combustion products exit the draft hood rather than going up the vent. Backdrafting is continuous spillage.

Causes of Spillage

Insufficient Draft:

- Blocked vent
- Undersized vent
- Cold chimney
- Inadequate height
- Poor vent design

Negative Building Pressure:

- Exhaust appliances
- Stack effect
- Wind effects
- Tight construction
- Return air leaks

Vent System Problems:

- Disconnected vent
- Improper slope
- Missing rise
- Damaged vent
- Improper common venting

Spillage Detection

Visual Signs:

- Moisture on windows
- Staining at draft hood
- Melted plastic nearby
- Rust on top of water heater
- Soot deposits

Test Methods:

1. **Match/Smoke Test:**
    - Hold at draft hood opening
    - Should draw steadily inward
    - Test after 5 minutes operation
    - Check all operating conditions
2. **Mirror Test:**
    - Cool mirror at draft hood
    - Condensation indicates spillage
    - Quick visual check
    - Not quantitative
3. **CO Testing:**
    - Measure at draft hood
    - Should be near zero
    - Indicates combustion products
    - Most reliable method

Preventing Spillage

Design Solutions:

- Proper vent sizing
- Adequate combustion air
- Sealed combustion appliances
- Power venting
- Induced draft

Installation Requirements:

- Minimum vent heights
- Proper connector rise
- Limited horizontal runs
- Correct termination
- Common venting rules

Building Modifications:

- Combustion air openings
- Pressure relief
- Interlock exhaust fans
- Separate appliance room
- Direct vent appliances

12.2 Venting Materials

Selecting appropriate venting materials is critical for safe operation and code compliance. Materials must withstand temperatures, corrosion, and environmental conditions.

Type B Gas Vent

Type B gas vent is the standard for venting Category I gas appliances with draft hoods.

Construction

Double Wall Design:

- Inner wall: Aluminum or stainless steel
- Outer wall: Galvanized steel
- Air space between walls
- Insulation value: R = 0.5 approximately
- Continuous air space

Features:

- Lightweight construction
- Snap-lock or twist-lock connections
- Factory-built sections
- Certified to ULC S636
- Listed for gas appliances

Available Sizes:

- 3" to 30" diameter standard

- Larger sizes special order
- Oval shapes available
- Various lengths
- Complete fitting selection

Temperature Ratings

Continuous Operation:

- 400°F (204°C) continuous
- 470°F (243°C) maximum
- Category I appliances only
- Not for solid fuel
- Not for liquid fuel

Safety Factors:

- Tested at higher temperatures
- Built-in safety margin
- Clearance requirements based on rating
- Listed for specific applications

Installation Standards

CSA B149.1 Requirements:

- 1" clearance to combustibles
- Proper support spacing
- Fire stop spacers required
- Listed termination caps
- Proper assembly method

Connection Methods:

1. **Twist-Lock:**
    - Rotate to lock
    - No screws required
    - Positive connection
    - Easy assembly
2. **Snap-Lock:**
    - Push together
    - Locking tabs engage
    - Some require screws
    - Check manufacturer

Type BW (Water Heater Vent)

Type BW vent is specifically designed for water heater installations.

Characteristics

Design Features:

- Oval or rectangular shape
- Fits between wall studs
- 5" round equivalent common
- Space-saving design
- Special fittings available

Applications:

- Residential water heaters
- Limited to 75,000 BTU/hr
- Natural draft only
- Single appliance only
- Not for common venting

Limitations:

- Maximum 50 feet developed length
- Two elbows maximum
- Specific clearances required
- Special termination required
- Not universal application

Category II, III, IV Materials

Modern high-efficiency appliances require special venting materials based on their operating characteristics.

Appliance Categories

Category Definitions:

Category	Pressure	Temperature	Condensing	Vent Material
I	Negative	High (>140°F)	No	Type B
II	Negative	Low (<140°F)	Yes	Special
III	Positive	High (>140°F)	No	Sealed
IV	Positive	Low (<140°F)	Yes	Plastic/Steel

Category II Materials

Requirements:

- Corrosion resistant
- Condensate handling
- Special materials required
- Limited availability

Materials:

- Stainless steel (AL29-4C)
- Special plastics (Polypropylene)
- Must be listed for Category II
- Manufacturer specific often

Challenges:

- Condensation in vent
- Natural draft with condensing
- Material compatibility
- Limited product options

Category III Materials

Requirements:

- Pressure-tight joints
- High temperature resistance
- No condensation expected
- Positive pressure rated

Common Materials:

- Stainless steel
- Sealed Type B (special)
- Must handle pressure
- Listed for application

Applications:

- Power vent water heaters
- Some commercial equipment
- Non-condensing power vent
- Medium efficiency units

Category IV Materials

Most Common High-Efficiency:

- Positive pressure
- Condensing operation
- Low temperature exhaust
- Special materials required

Approved Materials:

- PVC (to 140°F/60°C)
- CPVC (to 180°F/82°C)
- Polypropylene (to 230°F/110°C)
- Stainless steel (universal)
- ABS (where permitted)

PVC/CPVC for Condensing Appliances

Plastic venting is common for Category IV condensing appliances due to low exhaust temperatures.

PVC (Polyvinyl Chloride)

Properties:

- Maximum temperature: 140°F (60°C)
- Schedule 40 typical
- White or gray color
- Solvent welded joints
- Cost effective

CSA/ULC Certification:

- Must be certified for venting
- CSA B149.1 requirements
- System 636 certification
- Solid core required
- Cellular core not permitted

Installation Requirements:

- Support every 3-4 feet
- Slope to appliance (1/4"/foot)
- Primer and cement required
- Cleanout tees recommended
- Condensate drainage

Size Selection:

- Per manufacturer tables
- 2" minimum typical
- 3" common size
- Larger for long runs
- Consider ambient temperature

CPVC (Chlorinated PVC)

Properties:

- Maximum temperature: 180°F (82°C)
- Higher temperature rating than PVC
- Schedule 40 or 80
- More expensive than PVC
- Tan/gray color typically

When Required:

- Exhaust temperature >140°F
- Safety margin desired
- Manufacturer specification
- Mixed appliance venting
- Commercial applications

Installation Differences:

- Special primer/cement
- Different expansion rate
- Higher cost
- Same support requirements
- Compatible fittings needed

Stainless Steel Systems

Stainless steel provides universal venting solution for all categories.

Types of Stainless Steel

AL29-4C:

- Superior corrosion resistance
- Designed for condensing
- Resists chloride attack
- Premium material

- Most expensive option

316L:

- Good corrosion resistance
- Common grade
- Acceptable for most applications
- Lower cost than AL29-4C
- Wide availability

304:

- Basic stainless steel
- Limited condensing use
- Budget option
- Check manufacturer approval
- Adequate for some applications

System Types

Rigid Systems:

- Welded or mechanical joints
- Single or double wall
- Sealed for positive pressure
- Various manufacturers
- Complete fitting selection

Flexible Liners:

- Chimney relining
- Corrugated construction
- Various grades available
- Sizing critical
- Special terminations

Special Features:

- Gasket sealed joints
- No welding required
- Modular construction
- Insulated options
- Complete systems

Material Selection per Appliance Category

Proper material selection ensures safe, compliant installations.

Selection Matrix

Appliance Type	Category	Recommended Materials	Notes
Natural Draft Furnace	I	Type B	Standard application
Induced Draft Furnace	I	Type B or single wall	Check manufacturer
Condensing Furnace	IV	PVC, CPVC, Stainless	Per manufacturer
Tank Water Heater	I	Type B, BW	Natural draft
Power Vent Water Heater	III	Stainless, special	Non-condensing
Condensing Water Heater	IV	PVC, CPVC, Stainless	Low temperature
Condensing Boiler	IV	PVC, CPVC, PP, SS	Check exhaust temp
Steam Boiler	I	Type B, chimney	High temperature

Manufacturer Requirements

Always Check:

- Installation instructions
- Certified vent materials
- Maximum lengths
- Termination kits
- Temperature ratings
- Special requirements

Warranty Considerations:

- Use specified materials
- Follow instructions exactly
- Document installation
- Keep receipts
- Register equipment

12.3 Venting System Design

Proper venting system design ensures adequate draft, prevents condensation, and complies with code requirements.

Sizing Vents per CSA B149.1 Tables

The Canadian gas code provides comprehensive tables for sizing vents based on appliance input, vent height, and configuration.

Using the Sizing Tables

Table Selection:

- Table 8.1: Single appliance Type B
- Table 8.2: Single appliance masonry chimney
- Table 8.3: Common vented Type B
- Table 8.4: Common vented masonry
- Table 8.5: Connector sizing

Input Information Needed:

1. Total appliance input (BTU/hr)
2. Vent height (feet)
3. Lateral length (if any)
4. Number of appliances
5. Type of vent material
6. Rise of connector

Reading the Tables:

1. Find appliance input row
2. Find vent height column
3. Intersection shows minimum size
4. Check connector table separately
5. Verify lateral limits
6. Apply correction factors

Example Sizing Calculation

Scenario: 100,000 BTU/hr water heater, 20 feet Type B vent, 5 feet connector

Step 1: Check Table 8.1 (Single Type B)

- Input: 100,000 BTU/hr
- Height: 20 feet
- Minimum vent size: 4"

Step 2: Check connector sizing (Table 8.5)

- Appliance input: 100,000 BTU/hr
- Connector rise: 5 feet
- Minimum connector: 4"

Step 3: Verify lateral limits

- 4" vent at 20 feet
- Maximum lateral: 6 feet
- 5 feet acceptable

Result: 4" Type B vent and 4" connector acceptable

Single Appliance Venting

Single appliance venting is the simplest configuration with one appliance connected to dedicated vent.

Design Considerations

Minimum Heights:

- Type B vent: 5 feet above draft hood
- Masonry chimney: 10 feet typical
- From draft hood to termination
- Includes connector rise

Connector Requirements:

- Minimum 1/4" per foot rise
- Maximum length = 75% of vent height
- Size equal to or larger than outlet
- Single wall acceptable with clearances
- Type B preferred

Termination Heights:

- 1 foot above roof penetration
- 2 feet higher than any portion within 10 feet
- 3 feet minimum above forced air inlet within 10 feet
- Local codes may be stricter

Sizing Methodology

Step-by-Step Process:

1. **Determine Input:**
    - Use appliance nameplate
    - Derate for altitude if required
    - Use total input for multiple burners
2. **Measure Height:**
    - From appliance outlet to termination
    - Include connector rise

    - Actual centerline distance
3. **Calculate Lateral:**
    - Total horizontal distance
    - Include offsets
    - Measure centerline
4. **Select Vent Size:**
    - Use appropriate table
    - Check minimum and maximum
    - Verify connector separately
5. **Check Special Conditions:**
    - Altitude corrections
    - Multiple elbows
    - Exterior vents
    - Tall vents (>40 feet)

Common Venting Requirements

Common venting connects multiple appliances to single vent system with specific rules for safe operation.

Basic Rules

CSA B149.1 Requirements:

- All appliances must be Category I
- Draft hoods required on all
- Cannot combine with solid fuel
- Special rules for fan-assisted
- Size for total input

Connector Arrangements:

- Enter vent at different levels preferred
- Maintain 1/4" per foot rise
- Size each connector separately
- Larger appliance lower if same level
- Support independently

Manifold Connections

Tee Connections:

- Use approved fittings
- 45° preferred over 90°
- Maintain rise after tee
- Size manifold for combined flow

- Support adequately

Offset Spacing:

- Vertical distance between connections
- Equal to one pipe diameter minimum
- Prevents interaction
- Improves draft distribution
- Reduces turbulence

Sizing Common Vents

Procedure:

1. Total all appliance inputs
2. Measure common vent height
3. Use common vent tables
4. Size each connector individually
5. Verify all requirements met

Special Considerations:

- Orphaned water heater rules
- Fan + natural draft combinations
- Minimum vent size requirements
- Maximum capacity limits
- Existing chimney evaluation

Maximum Vent Length

Vent length limitations prevent excessive cooling and condensation.

Lateral Length Limits

Type B Vent:

- Maximum lateral = 75% of vertical height
- Measured centerline to centerline
- Includes all horizontal portions
- More restrictive for smaller diameters

Example Calculations:

- 20-foot vertical height
- Maximum lateral = 15 feet
- Includes connector horizontal

- Plus any offsets

Total Developed Length

Definition:

- Actual centerline distance
- Includes vertical and horizontal
- Accounts for all fittings
- Used for pressure calculations

Category IV Limits:

- Manufacturer specified
- Based on pressure capability
- Includes equivalent lengths
- Terminal fitting effects

Offsets and Elbows

Fittings add resistance and affect venting performance.

Equivalent Lengths

Typical Values:

Fitting Type	Equivalent Length
90° Elbow	5 feet
45° Elbow	2.5 feet
Tee (straight)	5 feet
Tee (branch)	10 feet
Termination	0-10 feet

Calculation Method:

1. Count all fittings
2. Multiply by equivalent length
3. Add to straight pipe length
4. Total = developed length
5. Check against maximum

Offset Limitations

45° Offsets Preferred:

- Less resistance than 90°
- Better flow characteristics
- Maintains velocity better
- Standard practice

Multiple Offsets:

- Avoid if possible
- Increases resistance significantly
- May require larger sizing
- Check manufacturer limits

Termination Requirements

Proper termination ensures adequate draft and prevents water entry.

Location Requirements

Roof Terminations:

- Above roof line minimum 1 foot
- 2 feet if within 10 feet of higher surface
- 3 feet for flat roofs
- Snow accumulation considerations
- Local code requirements

Wall Terminations:

- Direct vent only typically
- 12" from openings minimum
- Above snow line
- Protected from damage
- Proper clearances maintained

Weather Protection

Rain Caps:

- Listed for vent system
- Proper size critical
- Wind resistant design
- Screen if required
- Removable for inspection

Storm Collars:

- Seal roof penetration
- Shed water away from vent
- Flexible for movement
- UV resistant materials
- Properly positioned

Clearances to Air Intakes

Preventing combustion products from entering building through air intakes is critical.

Minimum Clearances

CSA B149.1 Requirements:

Termination Location	Forced Air Inlet	Gravity Inlet	Openable Window
Above	3 feet	1 foot	1 foot*
Horizontal	10 feet	3 feet	3 feet*
Below	Not permitted	Not permitted	4 feet*

*Direct vent appliances have different requirements

Special Considerations

Adjacent Buildings:

- Consider neighbor's openings
- Property line restrictions
- Local bylaws may apply
- Nuisance prevention

Multiple Terminations:

- Spacing between vents
- Avoid recirculation
- Stack effect considerations
- Combined plume effects

12.4 Type B Vent Installation

Proper installation of Type B vent ensures safe operation and code compliance.

Assembly Requirements

Type B vent must be assembled according to manufacturer instructions and code requirements.

Component Identification

Pipe Sections:

- Straight lengths (1', 2', 3', 4', 5')
- Adjustable lengths
- Male and female ends
- Proper orientation critical

Fittings:

- Elbows (15°, 30°, 45°, 90°)
- Tees (straight and reducing)
- Increasers and reducers
- Wyes and offsets
- Termination caps

Accessories:

- Support brackets
- Fire stop spacers
- Storm collars
- Roof flashings
- Wall thimbles

Assembly Procedures

Step-by-Step Assembly:

1. **Preparation:**
    - Verify all components present
    - Check for damage
    - Confirm sizes correct
    - Review instructions
2. **Connection Method:**
    - Male end down (female up)
    - Prevents condensate leakage
    - Align properly before joining
    - Twist-lock or snap-lock fully
3. **Securing Joints:**
    - Sheet metal screws if required
    - Three equally spaced
    - Don't penetrate inner wall
    - Check manufacturer requirements

4. **Testing Assembly:**
    - Check all joints tight
    - No gaps visible
    - Proper alignment
    - Support before releasing

Support Spacing

Adequate support prevents sagging and joint separation.

Code Requirements

CSA B149.1 Support Spacing:

Vent Diameter	Maximum Support Spacing
3" - 5"	6 feet
6" - 12"	8 feet
14" and larger	10 feet

Support Types:

- Wall brackets
- Ceiling brackets
- Roof brackets
- Guy wires (tall vents)
- Base supports

Installation Details

Wall Brackets:

- Secure to framing
- Not to drywall alone
- Level installation
- Allow for expansion
- Don't overtighten

Ceiling/Floor Penetrations:

- Fire stop spacer required
- Maintains clearance
- Provides support
- Fire-rated assembly
- Proper installation critical

Roof Support:

- Roof bracket or flashing
- Adequate for wind/snow loads
- Sealed weathertight
- Proper pitch maintained
- Guy wires if needed

Clearances to Combustibles

Maintaining proper clearances prevents fire hazards.

Standard Clearances

Type B Vent Requirements:

Location	Minimum Clearance
Standard installation	1 inch
Attic/concealed space	1 inch
Exterior wall (outside)	0 inches
Fire stop spacer	Built-in

Measurement Points:

- From outer wall of vent
- To nearest combustible
- Include insulation
- Consider building movement
- Maintain continuously

Special Situations

Reduced Clearances:

- Not permitted for Type B
- Use listed shields if needed
- Maintain air circulation
- Don't pack insulation
- Follow manufacturer limits

Combustible Penetrations:

- Use fire stop spacer
- Listed assembly required
- Maintain full clearance

- Seal penetration properly
- Multiple story considerations

Slope Requirements

Proper slope ensures condensate drainage and maintains draft.

Horizontal Runs

Minimum Slope:

- 1/4 inch per foot minimum
- Toward appliance preferred
- Away acceptable if necessary
- No sags permitted
- Check with level

Maximum Horizontal:

- 75% of vertical height
- Measured centerline
- Includes connector
- More restrictive for small sizes
- Verify with tables

Connector Slope

Requirements:

- 1/4 inch per foot minimum upward
- No downward slope permitted
- Continuous rise required
- Check entire run
- Adjust hangers as needed

Common Problems:

- Sagging over time
- Improper support
- Thermal expansion
- Building settlement
- Poor initial installation

Connector Sizing and Length

Vent connectors link appliances to main vent system.

Sizing Requirements

Basic Rules:

- Not smaller than appliance outlet
- Per CSA B149.1 tables
- Consider rise available
- Check common vent effects
- May need to increase

Single Wall Connectors:

- Permitted with clearances
- 6" clearance to combustibles
- 18" clearance above draft hood
- Galvanized steel typical
- Secure joints required

Type B Connectors:

- 1" clearance to combustibles
- Preferred for safety
- Same assembly rules
- More expensive
- Listed connectors only

Length Limitations

Maximum Length:

- 75% of vertical vent height
- 1.5 feet per inch diameter
- Whichever is less
- Measured centerline
- Includes horizontal portion

Example:

- 4" connector
- 20 feet vertical vent
- Maximum: 6 feet or 15 feet
- Use 6 feet (more restrictive)

Termination Height and Location

Proper termination ensures adequate draft and weather protection.

Height Requirements

Above Roof:

Roof Pitch	Minimum Height Above Roof
Flat to 6/12	1 foot
6/12 to 8/12	1.5 feet
8/12 to 12/12	2 feet
Over 12/12	2 feet + 10% of pitch

Additional Requirements:

- 2 feet higher than any surface within 10 feet
- Consider snow accumulation
- Local codes may exceed
- Measure from high side

Location Considerations

Optimal Placement:

- Near ridge preferred
- Away from valleys
- Avoid wind turbulence zones
- Clear of trees
- Accessible for maintenance

Problem Locations:

- Building corners
- Near higher structures
- Adjacent to walls
- Under overhangs
- In courtyards

Cap Requirements

Vent caps protect system while maintaining proper draft.

Types of Caps

Standard Cap:

- Listed for Type B vent
- Sized for specific diameter

- Wind band included
- Removable for cleaning
- Corrosion resistant

Special Caps:

- High wind designs
- Vacu-stack types
- Power assist options
- Bird screens available
- Snow cone designs

Installation Requirements

Proper Installation:

1. Correct size essential
2. Fully seated on vent
3. Secured per manufacturer
4. Level installation
5. Clear of obstructions

Maintenance Access:

- Removable for inspection
- Annual check recommended
- Clear debris
- Check for damage
- Verify secure attachment

12.5 Direct Vent Systems

Direct vent systems draw combustion air from outside and exhaust products outside, isolating the combustion process from indoor air.

Concentric Vent Design

Concentric vents use pipe-within-pipe construction for intake and exhaust.

Construction Features

Design Characteristics:

- Inner pipe carries exhaust

- Outer pipe brings combustion air
- Air preheated by exhaust
- Single penetration required
- Factory-assembled components

Materials:

- Inner: Aluminum or stainless steel
- Outer: Galvanized steel
- Gasket sealed joints
- Twist-lock connections
- Complete system approach

Advantages:

- Single wall/roof penetration
- Combustion air preheating
- Balanced system
- Reduced clearances possible
- Aesthetic appearance

System Components

Pipe Sections:

- Various lengths available
- Adjustable sections
- Rigid construction
- Telescoping options
- Special order lengths

Fittings:

- 45° and 90° elbows
- Offset assemblies
- Increasers (if permitted)
- Wall thimbles
- Roof flashings

Terminations:

- Horizontal caps
- Vertical caps
- Snorkel designs
- High wind versions
- Screen options

Horizontal Terminations

Horizontal venting through sidewall is common for direct vent appliances.

Location Requirements

Clearances per CSA B149.1:

From:	Minimum Distance
Grade level	12 inches*
Window/door (openable)	12 inches*
Window (fixed)	12 inches*
Corner of building	12 inches*
Under soffit (vented)	18 inches*
Gas meter/regulator	3 feet horizontal, 6 feet vertical
Forced air inlet	3 feet
Above paved sidewalk	7 feet

*Or per manufacturer if greater

Installation Procedures

Wall Penetration:

1. Select appropriate location
2. Verify clearances met
3. Check interior obstructions
4. Cut proper size hole
5. Install wall thimble
6. Maintain proper slope

Termination Assembly:

1. Install per manufacturer
2. Secure to wall properly
3. Seal weathertight
4. Maintain clearances
5. Install protective cage if needed

Pipe Routing:

1. Support every 4 feet
2. Maintain slope to terminal
3. Secure joints properly

4. Check total length
5. Minimize elbows

Vertical Terminations

Vertical termination through roof provides traditional appearance and good performance.

Advantages

Performance Benefits:

- Natural buoyancy assist
- Better in wind
- Less affected by snow
- No wall staining
- Quieter operation

Installation Benefits:

- Standard roof penetration
- Familiar to installers
- Good for tight lots
- Above snow line
- Less visible from ground

Installation Requirements

Roof Penetration:

1. Select location carefully
2. Check rafter/truss location
3. Cut appropriate hole
4. Install fire stop/support
5. Flash properly
6. Install storm collar

Vertical Height:

- Minimum per manufacturer
- Same as Type B requirements typically
- Consider snow depth
- Wind exposure
- Aesthetic preferences

Clearance Requirements

Direct vent systems have specific clearance requirements for safe operation.

Combustible Clearances

During Routing:

- 1" typical for listed systems
- 3" for generic systems
- Check manufacturer specifications
- Fire stop requirements
- Insulation shield needs

At Termination:

- Heat affects area around cap
- Follow manufacturer requirements
- Consider vinyl siding
- Protect combustible materials
- Use wall shields if needed

Service Clearances

Maintenance Access:

- 12" minimum working space
- Access to joints
- Cleaning accessibility
- Component replacement space
- Emergency shut-off access

Manufacturer Specifications

Each manufacturer has specific requirements that must be followed.

Critical Specifications

Must Follow Exactly:

- Maximum vent length
- Number of elbows allowed
- Termination kit requirements
- Pipe manufacturer/type
- Joint sealing method
- Support requirements

Equivalent Length Calculations:

Component	Typical Equivalent Length
90° Elbow	5 feet
45° Elbow	2.5 feet
Horizontal termination	5 feet
Vertical termination	0 feet

Example Calculation:

- 20 feet straight pipe
- Two 90° elbows (10 feet)
- One 45° elbow (2.5 feet)
- Horizontal termination (5 feet)
- Total equivalent: 37.5 feet

Approved Materials

Use Only Listed Components:

- Same manufacturer preferred
- Approved alternatives listed
- No substitutions
- Complete system approach
- Warranty considerations

Documentation Requirements:

- Keep installation instructions
- Record serial numbers
- Note vent configuration
- Photo documentation helpful
- File for future reference

Installation in Cold Climates

Cold climate installations require special considerations.

Freezing Concerns

Potential Problems:

- Condensate freezing in intake
- Ice blocking termination
- Frost accumulation
- Snow coverage
- Thermal shock

Prevention Strategies:

- Proper termination height
- Snow cone terminations
- Larger diameter systems
- Insulated options
- Heat tape (where approved)

Condensation Management

Cold Climate Issues:

- Increased condensation
- Freeze/thaw cycles
- Ice damming
- Blocked drains
- Material stress

Solutions:

- Slope to appliance
- Larger condensate drains
- Heat traced drains
- Indoor drain routing
- Regular maintenance

Special Termination Designs

Snorkel Kits:

- Elevates above snow
- Reduces blockage risk
- Available heights vary
- Wind resistant designs
- Professional appearance

Concentric Extensions:

- Adds vertical height
- Through roof options
- Maintains balance
- Factory designs
- Listed combinations only

12.6 Power Venting

Power venting uses mechanical means to remove combustion products, overcoming draft limitations and allowing flexible venting design.

Induced Draft Systems

Induced draft creates negative pressure in the vent system by pulling combustion products through.

System Design

Components:

- Inducer fan motor
- Pressure switch
- Vent system
- Control circuit
- Safety interlocks

Operating Sequence:

1. Call for heat
2. Inducer starts
3. Pressure switch proves operation
4. Pre-purge period
5. Ignition sequence
6. Normal operation
7. Post-purge on shutdown

Advantages:

- Overcomes draft problems
- Longer vent runs possible
- Flexible routing
- Consistent operation
- Handles wind conditions

Motor Types

PSC Motors:

- Permanent split capacitor
- Single speed typically
- Lower cost
- Simple replacement

- 120VAC operation

ECM Motors:

- Electronically commutated
- Variable speed capable
- Energy efficient
- Quieter operation
- Diagnostic capabilities

Motor Specifications:

- CFM rating
- Static pressure capability
- Temperature rating
- Moisture protection
- Bearing type

Pressure Switch Operation

Function:

- Proves inducer operation
- Senses negative pressure
- Safety interlock
- Prevents operation without draft

Testing:

1. Check with manometer
2. Verify setpoint
3. Test hose connections
4. Check for blockages
5. Confirm electrical operation

Forced Draft Systems

Forced draft pushes combustion products through vent system under positive pressure.

Design Differences

Key Characteristics:

- Positive vent pressure
- Sealed vent required
- Different materials needed

- Category III or IV
- Special safety requirements

Components:

- Power burner or fan
- Sealed vent system
- Pressure relief
- Condensate management
- Advanced controls

Safety Considerations

Additional Requirements:

- Vent integrity critical
- Joint sealing mandatory
- Pressure testing required
- Special materials only
- Regular inspection needed

Failure Modes:

- Joint leakage danger
- CO escape possible
- Pressure switch critical
- Blocked vent detection
- Maintenance essential

Vent Materials and Sizing

Power vented systems require appropriate materials and sizing.

Material Requirements

Category III (Non-condensing):

- Stainless steel common
- Sealed Type B special
- AL vent systems
- Must handle temperature
- Positive pressure rated

Category IV (Condensing):

- PVC/CPVC common

- Polypropylene available
- Stainless steel universal
- Per manufacturer specs
- Temperature appropriate

Sizing Methodology

Manufacturer Tables:

- Specific to equipment
- Based on:
    - Input rate
    - Total equivalent length
    - Number of elbows
    - Altitude
    - Temperature

Pressure Drop Calculations:

```
Total Pressure = Static + Velocity + Fitting Losses
```

Example Sizing:

- 100,000 BTU/hr furnace
- 40 feet equivalent length
- Manufacturer table shows: 2" PVC
- Maximum length: 60 feet
- Acceptable installation

Electrical Interlocks

Safety interlocks prevent operation without proper venting.

Required Interlocks

Pressure Switch:

- Must close before ignition
- Opens on blockage
- Wired in safety circuit
- Manual reset versions available

Auxiliary Switches:

- High temperature limit
- Blocked vent detection

- Condensate overflow
- Motor current sensing

Wiring Requirements

Control Circuit:

```
L1 → Pressure Switch → Limit → Gas Valve → L2
```

Safety Requirements:

- Series circuit mandatory
- No bypassing permitted
- Proper wire gauge
- Moisture resistant connections
- Code compliance

Condensate Handling

Power venting often produces condensate requiring management.

Condensate Production

Factors:

- Efficiency level
- Return air temperature
- Vent length
- Outdoor temperature
- Run time

Typical Rates:

- 90% furnace: 0.5-1.0 gallon/hour
- 95% furnace: 0.75-1.5 gallons/hour
- Varies with conditions

Drainage Systems

Components:

- Condensate trap
- Drain lines
- Neutralizer (if required)
- Overflow protection
- Clean-out provisions

Installation:

1. Install trap per manufacturer
2. Slope drain lines 1/4"/foot
3. Route to approved drain
4. Provide overflow protection
5. Insulate if freezing possible

Safety Controls

Power vent systems require comprehensive safety controls.

Primary Controls

Essential Safeties:

- Pressure switch
- High limit
- Flame safeguard
- Blocked vent switch
- Roll-out switches

Testing Procedures:

1. Block vent partially
2. Verify shutdown
3. Check restart prevention
4. Test each safety
5. Document results

Maintenance Requirements

Regular Service:

- Annual inspection minimum
- Motor lubrication
- Pressure switch testing
- Vent inspection
- Condensate system cleaning

Component Life:

- Motors: 10-15 years typical
- Pressure switches: 5-10 years
- Controls: 10-20 years
- Vent system: 20+ years

12.7 Condensate Management

High-efficiency appliances produce acidic condensate requiring proper handling to prevent damage and ensure safe disposal.

Condensate Production

Understanding condensate formation helps predict quantities and management needs.

Formation Process

Dew Point Basics:

- Water vapor in combustion products
- Condenses below 140°F (60°C)
- Natural gas: ~120°F dew point
- Propane: ~125°F dew point
- Occurs in heat exchanger

Chemical Composition:

- Water (H_2O) primary
- Carbonic acid (H_2CO_3)
- Nitric acid (HNO_3) traces
- pH typically 3.2-4.5
- Corrosive properties

Production Rates

Calculation Method:

```
Condensate (gallons/hour) = Input (BTU/hr) × Efficiency × 0.000013
```

Example:

- 100,000 BTU/hr furnace
- 95% efficiency
- Condensate = 100,000 × 0.95 × 0.000013
- = 1.24 gallons/hour maximum

Typical Rates:

Appliance Type	Efficiency	Condensate Rate
Mid-efficiency furnace	80-83%	Minimal/none
Condensing furnace	90-98%	0.5-1.5 gal/hr
Condensing boiler	85-95%	1.0-3.0 gal/hr
Tankless water heater	85-98%	0.5-2.0 gal/hr

Drain Requirements

Proper drainage prevents equipment damage and water problems.

Code Requirements

CSA B149.1 Specifications:

- Drain to approved location
- Indirect connection required
- Air gap or trap seal
- Accessible for cleaning
- Protected from freezing

Approved Drain Points:

- Floor drain (with trap primer)
- Laundry tub
- Condensate pump
- Indirect waste receptor
- Outside (climate permitting)

Not Acceptable:

- Direct to septic system
- Roof drains
- Foundation drains
- Direct sewer connection

Piping Materials

Acceptable Materials:

- PVC (Schedule 40)
- CPVC
- Polypropylene
- Stainless steel
- Cast iron (with treatment)

Not Acceptable:

- Copper (corrodes)
- Galvanized steel (corrodes)
- ABS (temperature limits)
- Flexible vinyl (not durable)

Neutralization (Where Required)

Some jurisdictions require neutralization of acidic condensate.

When Required

Typical Requirements:

- Commercial installations
- Cast iron drainage systems
- Septic system discharge
- Local code requirement
- Manufacturer specification

pH Requirements:

- Typical condensate: 3.2-4.5 pH
- Required after treatment: >5.0 pH
- Target: 6.0-7.0 pH
- Test periodically

Neutralizer Types

Cartridge Systems:

- Replaceable media
- Calcium carbonate typical
- 1-2 year replacement
- Flow-through design
- Various sizes available

Bulk Media Systems:

- Larger capacity
- Marble chips common
- Longer service life
- Requires periodic addition
- Lower operating cost

Installation

Proper Configuration:

1. Install after trap
2. Before drainage point
3. Accessible location
4. Bypass for service
5. Sample ports recommended

Sizing:

- Based on BTU input
- Condensate flow rate
- Media consumption rate
- Manufacturer tables
- Safety factor included

Freeze Protection

Preventing condensate freezing avoids blockages and equipment damage.

Problem Areas

Common Freeze Points:

- Exterior drain lines
- Unheated spaces
- Attics
- Crawl spaces
- Garage routing

Consequences:

- Blocked drainage
- Equipment shutdown
- Water damage
- Heat exchanger damage
- Safety hazards

Protection Methods

Insulation:

- Pipe insulation minimum
- Heat tape if necessary

- Larger diameter pipe
- Minimize exterior routing
- Seal penetrations

Heat Tracing:

- Self-regulating cable
- Thermostat control
- Proper installation critical
- Insulate over heat tape
- GFCI protection required

Alternative Routing:

- Keep indoors when possible
- Use conditioned spaces
- Condensate pump to inside drain
- Secondary drain provisions
- Emergency overflow protection

Trap Requirements

Traps prevent air flow through drain while allowing condensate flow.

Trap Design

Requirements:

- Depth per manufacturer
- Typically 3-4" minimum
- Must maintain seal
- Cleanout provision
- Proper venting

Types:

- Built-in (appliance)
- Field-fabricated
- Running trap
- Bottle trap
- P-trap configuration

Installation Details

Proper Installation:

1. Follow manufacturer design
2. Prime before operation
3. Secure all connections
4. Provide cleanout
5. Protect from freezing

Common Problems:

- Dry trap (loss of seal)
- Blocked trap
- Improper depth
- Negative pressure effects
- Freezing

Testing Condensate Systems

Regular testing ensures proper operation and prevents problems.

Flow Testing

Procedure:

1. Run appliance 15 minutes
2. Observe condensate flow
3. Check for leaks
4. Verify drainage rate
5. Test overflow protection

Expected Results:

- Steady flow during operation
- No backups
- Proper trap operation
- Clear drainage
- No leaks

pH Testing

When Required:

- Initial commissioning
- Annual service
- Neutralizer service
- Problem diagnosis
- Code requirement

Test Procedure:

1. Collect sample
2. Use pH meter or strips
3. Record reading
4. Compare to requirements
5. Adjust treatment if needed

Maintenance Schedule

Regular Service:

Task	Frequency	Notes
Visual inspection	Monthly	Homeowner task
Clean trap	Annually	Service tech
Test pH	Annually	If neutralizer present
Replace media	1-2 years	Per manufacturer
Flush system	Annually	Remove deposits
Check overflow	Annually	Verify operation

12.8 Troubleshooting Venting Problems

Systematic troubleshooting identifies and corrects venting issues that can cause equipment problems and safety hazards.

Spillage Detection and Correction

Spillage of combustion products into living space poses serious health and safety risks.

Detection Methods

Visual Indicators:

- Melted plastic near draft hood
- Soot deposits on equipment
- Rust stains on top of appliance
- Moisture/condensation patterns
- Scorching above draft hood

Testing Procedures:

1. **Smoke Test:**
    - Generate smoke at draft hood

    - Should draw into vent
    - Test worst-case conditions
    - Document results
2. **Mirror Test:**
    - Hold mirror at draft hood
    - Condensation indicates spillage
    - Quick screening method
    - Follow with detailed testing
3. **CO Testing:**
    - Measure ambient CO levels
    - Test at draft hood
    - During various conditions
    - Document readings
4. **Chemical Smoke:**
    - Professional smoke generators
    - Shows air patterns
    - Identifies problem areas
    - Video documentation helpful

Common Causes

Vent System Problems:

Problem	Symptoms	Solution
Blocked vent	Complete spillage	Clear obstruction
Undersized vent	Intermittent spillage	Resize per code
Disconnected vent	Continuous spillage	Reconnect properly
Improper slope	Poor draft	Correct slope
Missing rise	Spillage at startup	Add vertical rise

Building Pressure:

- Exhaust fans operating
- Return air leaks
- Stack effect
- Wind effects
- Tight construction

Corrective Actions

Immediate Actions:

1. Shut down appliance
2. Ventilate area
3. Check for CO

4. Identify cause
5. Do not restart until corrected

Permanent Solutions:

- Resize venting system
- Provide combustion air
- Install powered vent
- Convert to direct vent
- Add makeup air system

Draft Measurement

Measuring draft quantifies venting system performance.

Test Equipment

Draft Gauges:

- Magnehelic gauge
- Digital manometer
- Inclined manometer
- Range: -0.5" to +0.5" W.C.
- Resolution: 0.005" minimum

Test Setup:

1. Drill 1/4" test hole
2. Location: 12" minimum from draft hood
3. Before any elbow
4. Insert probe properly
5. Seal around probe

Measurement Procedures

Standard Test:

1. Operate appliance 5 minutes
2. Close all doors/windows
3. Normal operating conditions
4. Record draft reading
5. Test multiple conditions

Worst-Case Test:

1. Close all doors/windows

2. Turn on all exhaust fans
3. Open/close doors repeatedly
4. Operate clothes dryer
5. Record minimum draft

Acceptable Readings:

- Natural draft: -0.02" to -0.05" W.C.
- Minimum: -0.01" W.C.
- Positive readings unacceptable
- Excessive draft problematic

Condensation Issues

Condensation in venting systems causes corrosion and operational problems.

Identifying Condensation

Signs:

- Water stains at joints
- Rust on vent connector
- Dripping from vent
- White deposits (efflorescence)
- Damaged vent material

Causes:

- Oversized venting
- Long connectors
- Excessive dilution air
- Cold chimney
- High-efficiency operation

Problem Diagnosis

Testing:

1. Measure flue gas temperature
2. Calculate dew point
3. Check vent sizing
4. Evaluate chimney condition
5. Review operating patterns

Contributing Factors:

- Short cycles
- Oversized equipment
- Exterior chimneys
- Unlined masonry
- Poor insulation

Solutions

Corrective Measures:

- Resize venting system
- Line masonry chimney
- Insulate vent system
- Reduce connector length
- Install AL29-4C liner
- Convert to power vent

Prevention:

- Proper sizing critical
- Maintain temperatures above dew point
- Regular operation
- Appropriate materials
- Professional design

Blockage Identification

Blocked vents cause spillage and equipment shutdown.

Common Blockages

Types and Locations:

Blockage Type	Common Location	Detection Method
Bird nests	Termination cap	Visual inspection
Debris	Base of chimney	Mirror/flashlight
Ice	Termination	Winter inspection
Soot	Heat exchanger outlet	Inspection camera
Collapsed liner	Chimney	Camera inspection

Inspection Methods

Visual Inspection:

- Termination cap

- Draft hood area
- Clean-out openings
- Connector joints
- Use mirrors and lights

Camera Inspection:

- Professional equipment
- Complete interior view
- Document conditions
- Identify exact location
- Before/after documentation

Performance Testing:

- Draft measurement
- Spillage testing
- Temperature measurement
- CO production
- Pressure testing

Clearing Procedures

Safe Removal:

1. Shut down equipment
2. Allow cooling
3. Remove termination cap
4. Clear visible blockage
5. Inspect with camera
6. Test operation

Professional Service:

- Chimney sweeping
- Mechanical cleaning
- Liner installation
- Major repairs
- Safety verification

Carbon Monoxide Production

CO production indicates combustion problems requiring immediate attention.

Acceptable Levels

CSA B149.1 Limits:

- Air-free CO: <100 ppm
- Ambient space: <10 ppm
- Action level: >50 ppm air-free
- Danger level: >100 ppm air-free

Health Effects:

CO Level (ppm)	Exposure Time	Effects
35	8 hours	Maximum workplace exposure
200	2-3 hours	Headache, fatigue
400	1-2 hours	Serious headache
800	45 minutes	Dizziness, nausea
1600	20 minutes	Death possible

Testing Procedures

Equipment Required:

- Combustion analyzer
- Ambient CO monitor
- Personal CO monitor
- Calibrated equipment
- Recording capability

Test Locations:

1. Flue gas sample
2. Draft hood spillage
3. Ambient room air
4. Supply registers
5. Around appliance

Causes and Solutions

High CO Causes:

Cause	Diagnosis	Solution
Insufficient air	High CO, low O_2	Provide combustion air
Overfired	High input rate	Adjust gas pressure
Impingement	Flame hitting surface	Adjust burners
Poor mixture	Yellow flames	Clean burners

Cause	Diagnosis	Solution
Blocked HX	High temperature	Clean heat exchanger

Corrective Actions

Systematic correction ensures safe, reliable operation.

Priority Actions

Immediate Safety:

1. High CO: Shut down immediately
2. Spillage: Shut down and ventilate
3. Blocked vent: Do not operate
4. Damaged vent: Repair before use
5. Document all conditions

Investigation Steps:

1. Interview occupants
2. Check maintenance history
3. Inspect entire system
4. Test under all conditions
5. Document findings

Repair Procedures

Common Repairs:

Problem	Repair Method	Verification
Undersized vent	Replace with proper size	Test draft
Blocked vent	Clear obstruction	Camera inspect
Disconnected	Reconnect and secure	Pressure test
Spillage	Correct cause	Smoke test
High CO	Adjust/clean burner	Combustion test

Documentation

Required Documentation:

- Initial conditions
- Test results
- Repairs performed
- Final test results

- Customer notification
- Follow-up recommended

Report Contents:

- Date and time
- Equipment information
- Problem description
- Test data
- Actions taken
- Recommendations
- Technician signature

Chapter Review

Summary

This chapter covered comprehensive venting system design, installation, and troubleshooting:

Venting Principles:

- Natural draft relies on buoyancy
- Temperature differential drives flow
- Building conditions affect performance
- Spillage prevention critical
- Proper design essential

Materials Selection:

- Category determines materials
- Type B for standard appliances
- PVC/CPVC for condensing units
- Stainless steel universal option
- Follow manufacturer specifications

System Design:

- Size per CSA B149.1 tables
- Consider height and configuration
- Limit horizontal runs
- Proper termination critical
- Common venting rules complex

Installation Requirements:

- Maintain clearances
- Proper support spacing
- Correct assembly methods
- Slope for drainage
- Weather protection needed

Special Systems:

- Direct vent isolates combustion
- Power venting overcomes limitations
- Condensate management essential
- Cold climate considerations
- Regular maintenance required

Troubleshooting:

- Systematic diagnosis important
- Safety always priority
- Multiple test methods
- Document everything
- Professional repairs often needed

Vent Sizing Calculations

Practice Problems

Problem 1: Single Appliance Given:

- Natural draft water heater
- Input: 40,000 BTU/hr
- Type B vent height: 15 feet
- Connector lateral: 4 feet

Solution:

- Check Table 8.1: 3" vent minimum
- Verify lateral limit: 11.25 feet maximum
- 4 feet acceptable
- Answer: 3" Type B vent

Problem 2: Common Venting Given:

- Furnace: 80,000 BTU/hr
- Water heater: 40,000 BTU/hr
- Common vent height: 25 feet
- Type B vent system

Solution:

- Total input: 120,000 BTU/hr
- Check Table 8.3: 5" common vent
- Size each connector separately
- Furnace connector: 4"
- Water heater connector: 3"

Problem 3: Equivalent Length Given:

- Direct vent furnace
- 15 feet straight pipe
- Two 90° elbows
- One 45° elbow
- Horizontal termination

Solution:

- Straight pipe: 15 feet
- 90° elbows: 2 × 5 = 10 feet
- 45° elbow: 2.5 feet
- Termination: 5 feet
- Total equivalent: 32.5 feet

Problem 4: Pressure Drop Given:

- 2" PVC vent
- 50 feet equivalent length
- 100,000 BTU/hr input

Check manufacturer table:

- Maximum length for 2": 60 feet
- 50 feet acceptable
- No upsizing required

Problem 5: Altitude Correction Given:

- Location: 5,000 feet elevation
- Sea level input: 100,000 BTU/hr
- Derating: 4% per 1,000 feet

Solution:

- Derating: 20% (5 × 4%)
- Effective input: 80,000 BTU/hr

- Size for 80,000 BTU/hr

Installation Planning Exercises

Exercise 1: New Installation Planning

Scenario: Installing 95% efficient furnace in basement

Planning Steps:

1. Determine appliance category (IV)
2. Select vent material (PVC)
3. Plan route to termination
4. Calculate equivalent length
5. Verify within limits
6. Plan condensate drainage
7. Check clearances
8. Order materials

Checklist:

- [ ] Manufacturer instructions
- [ ] Vent sizing confirmed
- [ ] Materials listed
- [ ] Clearances verified
- [ ] Condensate planned
- [ ] Permits obtained
- [ ] Testing equipment ready

Exercise 2: Replacement Planning

Scenario: Replacing 80% furnace with 95% model

Considerations:

1. Existing vent not usable
2. New vent material required
3. Condensate drainage needed
4. Electrical upgrade possible
5. Combustion air changes
6. Orphaned water heater

Solutions:

- Install new PVC venting
- Add condensate pump

- Resize water heater vent
- Provide combustion air
- Update gas piping

Code Compliance Assessments

Assessment Checklist

Type B Vent Installation:

- [ ] Proper clearances (1" minimum)
- [ ] Support spacing correct
- [ ] Connector slope adequate (1/4"/ft)
- [ ] Height requirements met
- [ ] Termination proper
- [ ] Fire stops installed
- [ ] Joints secure
- [ ] Listed cap installed

Direct Vent Installation:

- [ ] Clearances from openings
- [ ] Manufacturer specs followed
- [ ] Proper materials used
- [ ] Joints sealed
- [ ] Slope correct
- [ ] Support adequate
- [ ] Termination approved
- [ ] Total length acceptable

Power Vent Installation:

- [ ] Electrical interlocks
- [ ] Pressure switch operation
- [ ] Material compatibility
- [ ] Condensate management
- [ ] Safety controls tested
- [ ] Documentation complete

Problem Diagnosis Scenarios

Scenario 1: Winter Spillage

Symptoms:

- Spillage during cold weather only

- Moisture on windows
- CO alarms occasionally
- Rust on water heater top

Diagnosis Process:

1. Test draft in cold conditions
2. Check for ice at termination
3. Measure building pressure
4. Inspect chimney condition
5. Evaluate stack effect

Findings:

- Negative draft when cold
- Exterior chimney problem
- Stack effect reversal
- Undersized vent

Solutions:

- Line chimney with AL29-4C
- Power vent conversion
- Provide combustion air
- Relocate to interior chimney

Scenario 2: Condensation Damage

Symptoms:

- Water stains at joints
- Rust on connector
- Vent deterioration
- Occasional spillage

Testing:

1. Measure flue temperature
2. Check vent sizing
3. Inspect chimney liner
4. Review operation patterns
5. Calculate dew point

Findings:

- Oversized vent system

- Low flue temperature
- Short cycling
- Exterior chimney

Solutions:

- Resize vent system
- Install liner
- Address short cycling
- Insulate chimney

Scenario 3: High CO Production

Symptoms:

- CO reading: 200 ppm air-free
- Yellow flames
- Soot on heat exchanger
- Customer headaches

Investigation:

1. Combustion analysis
2. Check gas pressure
3. Inspect burners
4. Verify air supply
5. Check venting

Findings:

- Insufficient combustion air
- Dirty burners
- Negative building pressure
- Partial vent blockage

Corrections:

1. Clean burners thoroughly
2. Provide combustion air
3. Clear vent obstruction
4. Adjust gas pressure
5. Retest combustion
6. Verify safe operation

Laboratory Exercises

Lab 1: Draft Measurement

Equipment:

- Draft gauge
- Test probes
- Drill and bits
- Operating appliance

Procedure:

1. Drill test hole properly
2. Zero gauge
3. Insert probe
4. Operate appliance 5 minutes
5. Record draft
6. Test various conditions
7. Document results

Expected Results:

- Natural draft: -0.02" to -0.05"
- Minimum acceptable: -0.01"
- Stable reading
- No positive pressure

Lab 2: Spillage Testing

Equipment:

- Smoke generator
- CO meter
- Mirror
- Camera

Procedure:

1. Set worst-case conditions
2. Operate appliance
3. Generate smoke at draft hood
4. Observe flow direction
5. Measure CO levels
6. Document with photos
7. Test corrections

Lab 3: Vent Sizing Exercise

Task: Size complete vent system for:

- 75,000 BTU/hr furnace
- 40,000 BTU/hr water heater
- Common venting
- 20-foot height
- Type B vent

Solution Process:

1. Total input: 115,000 BTU/hr
2. Check common vent table
3. Size: 5" common vent
4. Individual connectors:
    - Furnace: 4"
    - Water heater: 3"
5. Verify all requirements

Final Assessment Questions

1. **What creates natural draft?**
    - Temperature differential and height
2. **When is manual reset required?**
    - Spillage on equipment >400,000 BTU/hr
3. **What is minimum Type B clearance?**
    - 1 inch to combustibles
4. **Calculate condensate production for 100,000 BTU/hr at 95% efficiency**
    - 1.24 gallons/hour maximum
5. **What materials suit Category IV?**
    - PVC, CPVC, Polypropylene, Stainless steel

Key Terms

AL29-4C: Premium stainless steel alloy specifically designed for condensing appliance venting with superior corrosion resistance.

Atmospheric Pressure: Air pressure at a given location affecting draft and combustion performance.

Backdrafting: Continuous spillage of combustion products into living space due to reversed vent flow.

Category I, II, III, IV: Classification system for gas appliances based on vent pressure and temperature characteristics.

Common Venting: Multiple appliances connected to single vent system following specific code requirements.

Concentric Vent: Pipe-within-pipe design for direct vent systems with exhaust inside and combustion air outside.

Condensate: Acidic water produced when combustion products cool below dew point temperature.

Connector: Pipe or vent section between appliance outlet and vertical vent or chimney.

Developed Length: Total centerline length including straight pipe plus equivalent length of all fittings.

Dew Point: Temperature at which water vapor in flue gas begins condensing.

Dilution Air: Secondary air entering through draft hood mixing with combustion products.

Direct Vent: Sealed combustion system drawing air from and exhausting to outdoors directly.

Draft: Negative pressure in venting system causing flow of combustion products.

Draft Hood: Device isolating appliance burner from variable chimney draft conditions.

Equivalent Length: Additional resistance of fittings expressed as straight pipe length.

Fire Stop Spacer: Listed device maintaining clearances through combustible floors/ceilings.

Induced Draft: Mechanical draft created by fan pulling combustion products through system.

Lateral: Horizontal portion of venting system including connectors and offsets.

Natural Draft: Buoyancy-driven flow without mechanical assistance.

Negative Pressure: Pressure below atmospheric causing inward flow direction.

Neutralizer: Device treating acidic condensate to raise pH before disposal.

Orphaned Water Heater: Water heater left on oversized common vent after furnace removal.

Positive Pressure: Pressure above atmospheric requiring sealed vent system.

Power Vent: Mechanical venting using fan to remove combustion products.

Spillage: Combustion products escaping into living space rather than venting outdoors.

Stack Effect: Building air movement due to temperature-induced density differences.

Termination: Vent system outlet to atmosphere including cap and clearances.

Type B Vent: Double-wall gas vent for Category I appliances with 1-inch clearance.

Type BW Vent: Special oval vent for water heaters fitting between wall studs.

Vent Connector: Pipe section from appliance to main vertical vent or chimney.

End of Chapter 12

This comprehensive chapter on Venting Systems provides essential knowledge for proper design, installation, and troubleshooting of gas appliance venting. Understanding these principles ensures safe removal of combustion products while maintaining efficient operation.

Students should be able to select appropriate materials, size venting systems using code tables, install various vent types properly, manage condensate, and diagnose venting problems. Regular inspection and maintenance of venting systems prevents dangerous conditions and ensures reliable operation.

Proper venting is critical for life safety. Always follow manufacturer instructions and code requirements exactly. When in doubt, consult with experienced professionals or manufacturers' technical support.