Canadian Gas Technician - Learning Module 12

Venting Systems

Comprehensive training on safe and compliant gas appliance venting design, installation, and troubleshooting

Learning Objectives

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

01

Explain the principles of natural draft and factors affecting venting performance

02

Select appropriate venting materials based on appliance category and application

03

Size venting systems according to CSA B149.1 requirements

04

Install Type B vent systems following code requirements

05

Configure direct vent and power vent systems properly

01

Design condensate management systems for high-efficiency appliances

02

Troubleshoot common venting problems and spillage issues

03

Perform draft measurements and interpret results

04

Identify unsafe venting conditions and implement corrections

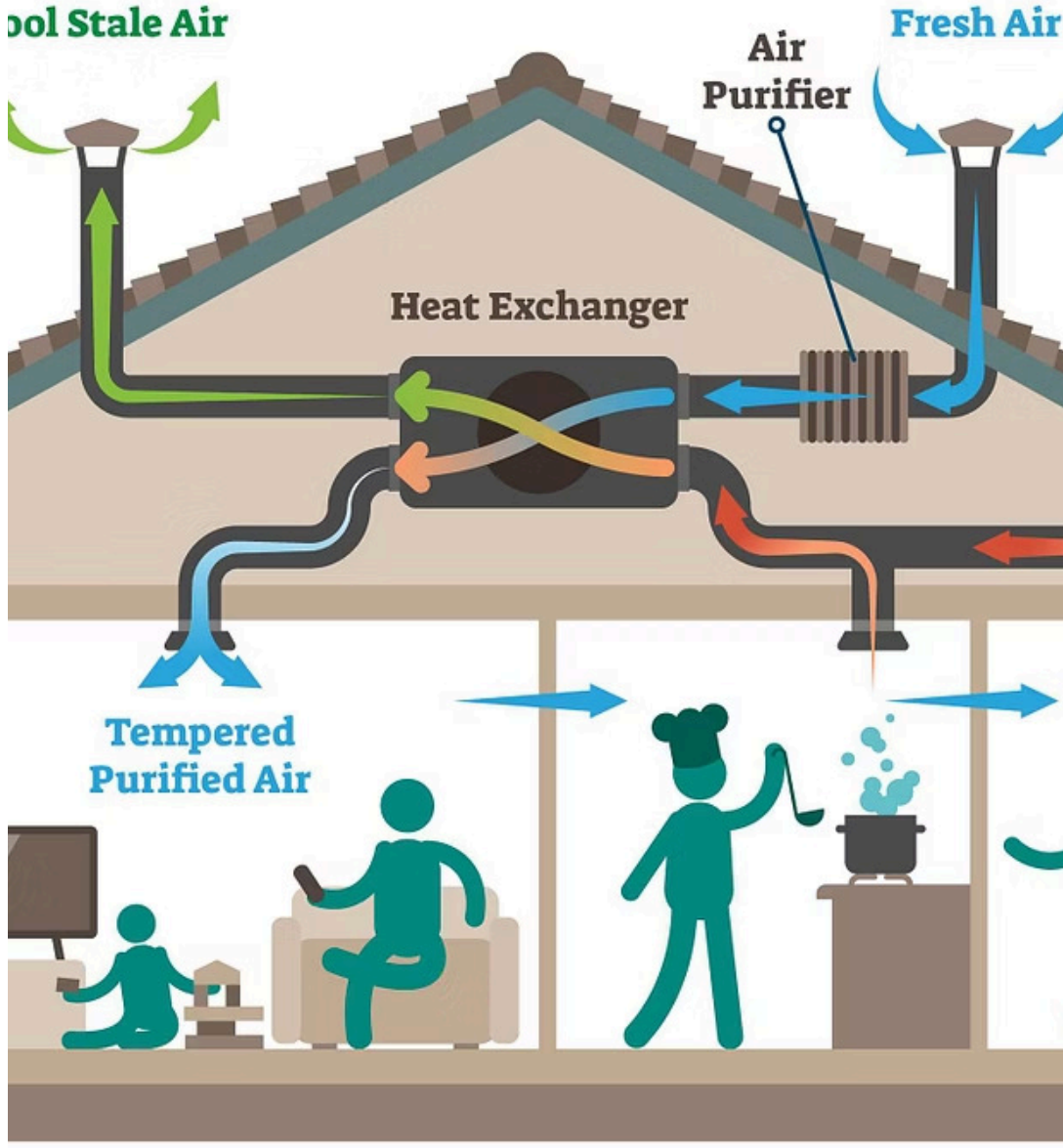
05

Apply manufacturer specifications and code requirements for complex venting scenarios

Section 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:

01

Match/Smoke Test:

- Hold at draft hood opening
- Should draw steadily inward
- Test after 5 minutes operation
- Check all operating conditions

02

Mirror Test:

- Cool mirror at draft hood
- Condensation indicates spillage
- Quick visual check
- Not quantitative

03

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

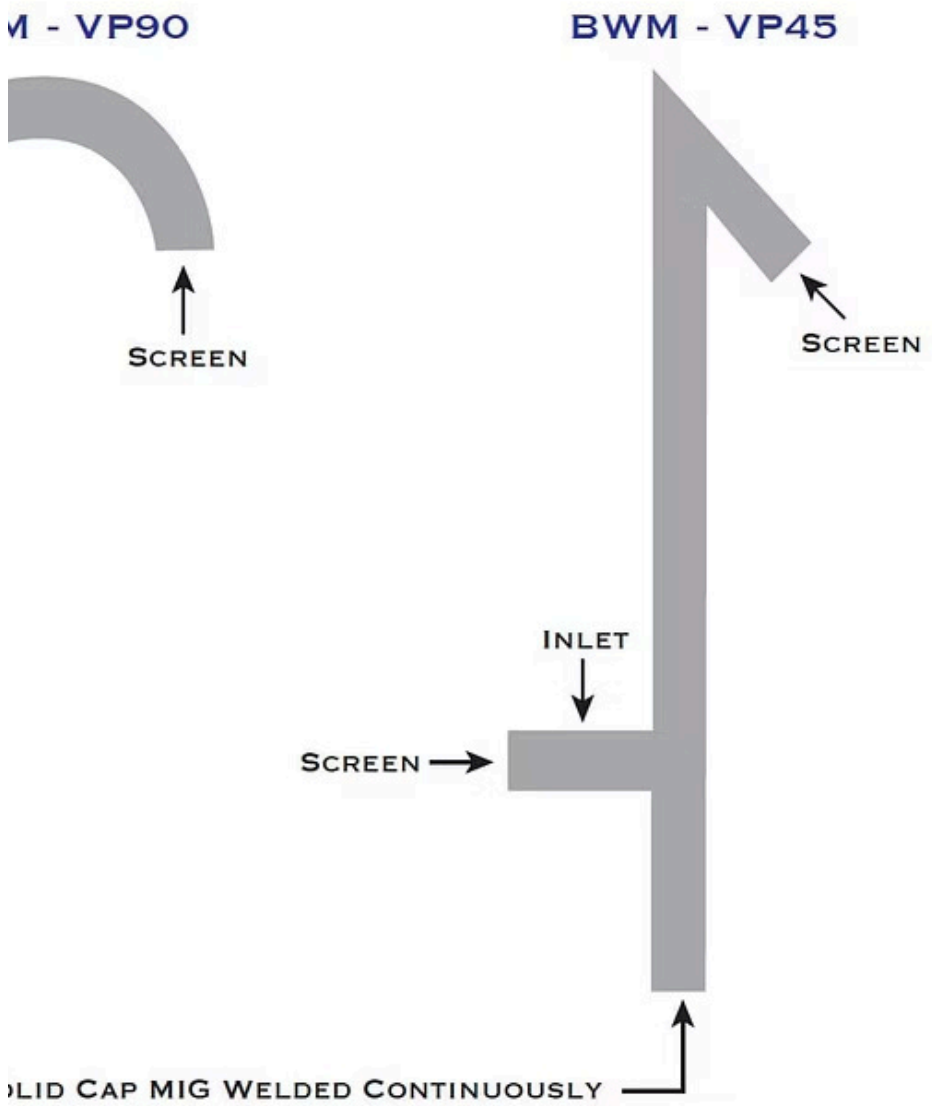
Building Modifications:

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

Section 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

Challenges:

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

Materials:

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

Category III Materials

Requirements:

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

Applications:

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

Common Materials:

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

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

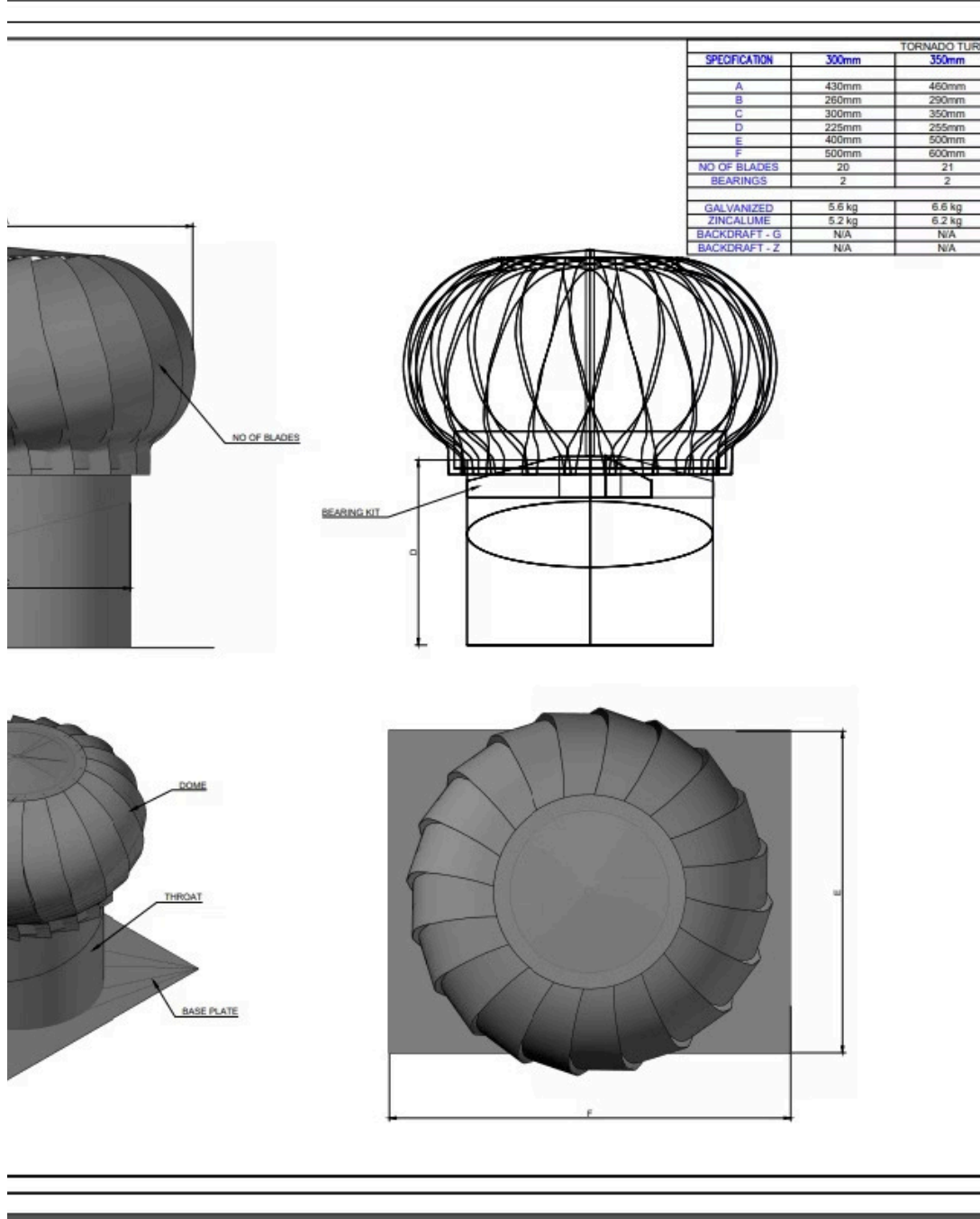
Warranty Considerations:

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

Section 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:

01

Determine Input:

- Use appliance nameplate
- Derate for altitude if required
- Use total input for multiple burners

02

Measure Height:

- From appliance outlet to termination
- Include connector rise
- Actual centerline distance

03

Calculate Lateral:

- Total horizontal distance
- Include offsets
- Measure centerline

04

Select Vent Size:

- Use appropriate table
- Check minimum and maximum
- Verify connector separately

05

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

Section 12.4

Type B Vent Installation

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

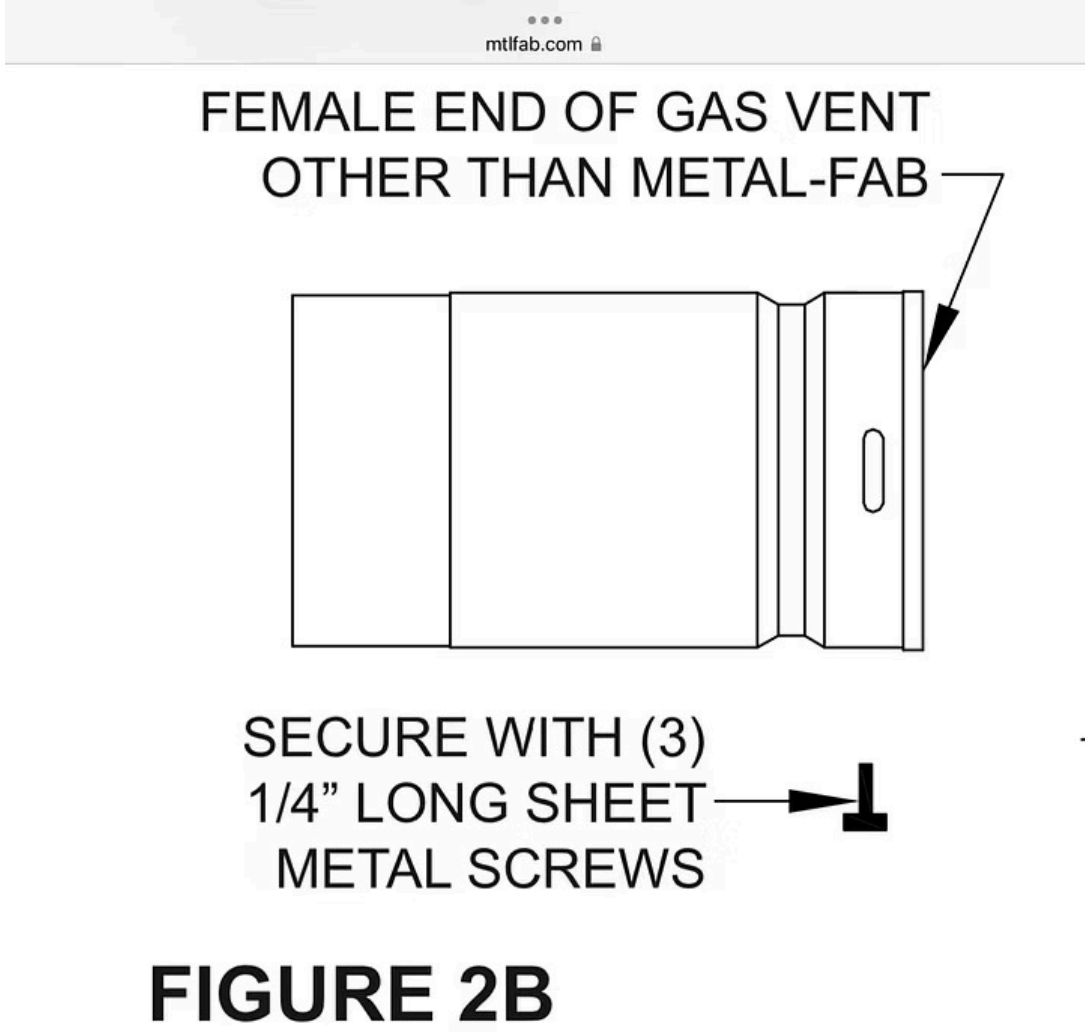


FIGURE 2B

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:

01

Preparation:

- Verify all components present
- Check for damage
- Confirm sizes correct
- Review instructions

02

Connection Method:

- Male end down (female up)
- Prevents condensate leakage
- Align properly before joining
- Twist-lock or snap-lock fully

03

Securing Joints:

- Sheet metal screws if required
- Three equally spaced
- Don't penetrate inner wall
- Check manufacturer requirements

04

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

Section 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:

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

Section 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

Advantages:

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

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

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

Section 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

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

Module Complete

You have completed Learning Module 12: Venting Systems. This comprehensive module covered venting principles, materials selection, system design, installation requirements, and troubleshooting procedures essential for safe gas appliance operation.