Special Gas Venting Systems
Proper System Design for Category IV Appliances
Special Gas Venting Systems

- National Fuel Gas Code (NFPA 54/ ANSI Z223.1)
  - Definition
    Gas vent for venting listed Category II, III, and IV appliances
Venting Categories

- Category I: NFGC (Non-Fuels, Gas and Combustible) with Negative Pressure
- Category II: Corrosion Resistant with Negative Pressure
- Category III: Airtight with Rise Above Dewpoint (°F)
- Category IV: Airtight Corrosion Resistant with Positive Pressure

Static Pressure in Vent vs Rise Above Dewpoint (°F)
**Category I.** An *appliance* that operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

**UL 441**

- **Static Pressure in Vent**
- **Rise above dew point °F**

**Graph:**
- Negative
- Positive

**Diagram:**
- Venting Categories
- UL 441 standard
Category II. An *appliance* that operates with a nonpositive vent static pressure and with a vent gas temperature that is capable of causing excessive condensate production in the vent.

**UL 1738**
**Venting Categories**

**Category III.** An *appliance* that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

**UL 103**
Category IV An *appliance* that operates with a positive vent static pressure and with a vent gas temperature that is capable of causing excessive condensate production in the vent.

**UL 1738**
Venting Category I

- Factory built – Double wall
- $550^\circ$ max flue gas temperature
- Gas fired appliances with draft hoods
- Negative of neutral pressure
- **Inner liner**
  - Type 110, 3003, or 3105 Aluminum
  - Type 430 SS
- **Outer liner**
  - Galvanized Steel or Aluminized Steel
Venting Category III

- UL 103
- Double wall – factory built
- 1,000° building heating appliance
- 1,400° continuous
- 1,800° intermittent
- 60” w.c. positive pressure rating
Venting Category II & IV

- UL 1738
  - Category II, III, & IV
  - Max exhaust temperature 550°F
  - Factory built double wall or single wall
  - Corrosive resistant test
  - Positive Pressure test
    - Min 1.25” WC
Special Gas Venting Systems

International Building Code

National Fuel Gas Code

NFGC (NFPA54/ANSI Z223.1)

International Mechanical Code

NFPA 211 Metal Chimneys

NFPA 31 Oil-Burning
Special Gas Venting Systems

- National Fuel Gas Code (NFPA 54/ ANSI Z223.1)
  - **Definition**
    “Special Type Gas Vent - Gas vent for venting listed Category II, III, and IV appliances”
  - **Sizing**
    “In accordance with the appliance manufacturer’s instructions”
  - **Support of Gas Vents**
    “In accordance with the manufacturer’s installation instructions”
  - **Termination**
    12” diameter or less – chart section 12.7.2
    > 12” diameter not less than 2ft above anything within 10ft horizontally.
  - **References to NFPA 211**
    Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances
NFPA 211 – Chapter 10 Vents

✓ 10.1.4
   A Special Gas Vent shall be listed and used in accordance with the terms of its listing and the appliance and vent manufacturers' instructions.

✓ 10.2 Size

✓ 10.2.1 General
   Vents shall be sized and configured in accordance with approved methods and the appliance and vent manufacturers’ instructions.

✓ 10.2.2 Gas Vents
   Gas vents shall be sized in accordance with NFPA 54, National Fuel Gas Code, or other approved methods, and the appliance and vent manufacturers’ instructions.
Special Gas Venting Systems

Code

Appliance Manufactures

Venting Manufactures
Appliance Mfg.'s Requirements

- Appliance Manufacture's Venting Guides
  - 2Mil BTU
    - Design information from appliance Manufactures
Appliance Mfg.'s Requirements

- Appliance Manufacture's Venting Guides
  - ✓ 2Mil BTU
    - System Design Exercise
      - Venting Category Requirement
      - Listings
      - Types of materials allowed
      - Design considerations
        - Outlet size
        - Outlet pressure requirements
        - Common venting
Appliance Mfg.'s Requirements

- Appliance Manufacture's Venting Guides
  - 2Mil BTU
    - System Design Exercise
      - Venting Category Requirement
        - Boiler A
          - II, IV
        - Boiler B
          - II, III, IV
          - 480° Temp
        - Boiler C
          - II, IV
        - Boiler D
          - II, IV
Appliance Mfg.'s Requirements

- Appliance Manufacture's Venting Guides
  - **2Mil BTU**
    - System Design Exercise
      - **Listings**
        - Boiler A
          - **UL 1738**
        - Boiler B
          - "listed as UL-1738 approved system"
        - Boiler C
          - "must be listed and labeled to UL1738"
        - Boiler D
          - "MUST be UL listed for use with cat. II, III, IV appliances"
Appliance Mfg.'s Requirements

Appliance Manufacture's Venting Guides

- 2Mil BTU
  - System Design Exercise
    - Types of materials allowed
      - Boiler A
        - AL29-4C
        - 316SS
        - CPVC
        - Polypropylene – Must be UL 1738 listed
      - Boiler B
        - AL29-4C – ONLY
        - UL 1738 Listed
      - Boiler C
        - Stainless steel – list manufactures with AL 29-4C
      - Boiler D
        - AL29-4C
        - 316L SS
Venting Materials – Stainless Steel

- UL 1738
- AL29-4C Stainless Steel Liner
  - Allegheny Ludlum
  - Superferritic (enhanced levels of chromium)
  - Higher corrosion resistance than 316 or 304 stainless
Venting Materials - CPVC

- Not UL listed or labeled
  - Not designed for use as Special Gas Venting

- Low temperature rating
  - Recommend up to 180 degrees
  - Max 200 degrees

- Limited Sizes and fittings
  - 4” – 8”
  - Special products above 10”

- Thermal Expansion
  - Greater than stainless steel
    • 4” in 100’ @ 100°
Venting Materials - PP

- Marketed as Special Gas Vent
  - Withstand temps to 230° F
  - Zero clearance to combustibles

- ETL listed
  - UL has not approved or listed

- Single wall
  - 6”-12” even diameters
Appliance Mfg.'s Requirements

- Appliance Manufacture's Venting Guides
  - 2MIL BTU
    - System Design Exercise
      - Design considerations
        - Outlet Size
          - Boiler A
            - 10"
          - Boiler B
            - 8"
          - Boiler C
            - 8"
          - Boiler D
            - 10"
Appliance Mfg.'s Requirements

- Appliance Manufacture's Venting Guides
  - **2Mil BTU**
    - System Design Exercise
      - *Design considerations*
        - Outlet Pressure Requirement
          - **Boiler A**
            - - .2” to .24” W.C.
          - **Boiler B**
            - - .25” to .81” W.C.
          - **Boiler C**
            - *Call manufacture*
          - **Boiler D**
            - - .04” to .35” W.C.
Appliance Mfg.'s Requirements

- Appliance Manufacture's Venting Guides
  - **2Mil BTU**
    - System Design Exercise
      - *Design considerations*
        - Common Venting
          - Boiler A
            - Yes, no more than 4 – consult design specialist
          - Boiler B
            - Yes
          - Boiler C
            - Yes, must use supplied damper, no sidewall venting
          - Boiler D
            - Yes, must ensure system is negative
Special Gas Venting Systems

- Who is responsible?
  - Appliance Manufacture?
    - Each with different requirements

- Why is proper system design important?
Proper System Design

- Draft – NFPA 54 – ANSI Z223.1

  - **Natural Draft**
    - Draft produced by the difference in the weight of a column of flue gases within a chimney or vent and a corresponding column of air equal dimension outside the chimney or vent

![Graph: Natural Draft Pressure Difference](image)

- Inside Temperature: 20 deg C, 68 deg F

The Engineering ToolBox
www.EngineeringToolBox.com
Proper System Design

- Pressure Drop Calculations - Cat III
  - Goal – Ensure exhaust flow
  - Boiler at High Fire/ High Ambient Temp
    - Ability to handle max/min CFM’s
  - Wide Operational Ranges
    - Typically 0” w.c + -.5 ?
Proper System Design

- Pressure Drop Calculations – Cat IV
  - Game Has Changed!
  - High Turn Down Ratios
    - Ability to run at low firing rates
  - Outlet Pressure Requirements
    - Tighter Tolerances
    - Positive pressure desired
    - Varies by Manufacture
    - Varies by Model
Draft Calculation

✓ Full Fire – 65° ambient temp

- 12”

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<tr>
<th>APPLIANCE</th>
<th>TOTAL</th>
<th>TOTAL</th>
<th>OUTLET</th>
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<td>PRESSURE</td>
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✓ Full Fire - 15° ambient temp

- 12”

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Draft Calculation

✓ 20% Fire – 65° ambient temp

- 12"

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✓ 20% Fire – 15° ambient temp

- 12"

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<td>Boiler1</td>
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Draft Calculation

✓ Outlet Pressure .05” to -.41”

Outlet Pressure Requirement

• Boiler A
  ✓ -.2” to .24” W.C.
• Boiler B
  ✓ -.25” to .81” W.C.
• Boiler C
  ✓ Call manufacture
• Boiler D
  ✓ -.04” to .35” W.C.
Boiler Errors

✓ Ignition Failure
  ▪ Problem typically increases in cold weather at COLD STARTS and in warm weather.

✓ Flame Failure
  ▪ Problem typically increases in cold weather typically occur in Lower Firing Rates.

✓ Air Switch Not Open or Not Closed
  ▪ Problem typically increases in cold weather when cycling hot Boilers and in Sealed Combustion applications.
Proper System Design

- Common Venting of High Efficiency Appliances
Elevation View*

Run 1
15'

Run 2
16'

Run 3

Run 4
28'

Run 5

Run 6

Plan View*

*Drawing not to scale
Proper System Design

- Common Venting of High Efficiency Appliances
  - All Boiler High Fire @ 65° outside temperature
    - Boiler 1 = .1996” wc
    - Boiler 2 = .1855” wc
    - Boiler 3 = .1203” wc
  - Inside Operational Outlet Pressure
    - Venting System is large enough to obtain full boiler operation.

Pressure range -.2” to .24”
Proper System Design

- Common Venting of High Efficiency Appliances
  - Two full one off @ 65° outside temperature
    - Boiler 1 = .0216” wc
    - Boiler 2 = .0075” wc
    - Boiler 3 = -1505” wc
  - Negative at off boiler

Pressure range -.2” to .24”
Proper System Design

Common Venting of High Efficiency Appliances

- All Boiler High Fire @ 0° outside temperature
  - Boiler 1 = .0350” wc
  - Boiler 2 = .0209” wc
  - Boiler 3 = -0.0442” wc

- Inside Operational Outlet Pressure

Pressure range -.2” to .24”
Proper System Design

- Common Venting of High Efficiency Appliances
  - All Boiler 50% Fire @ 0° outside temperature
    - Boiler 1 = -.2730” wc
    - Boiler 2 = -.2779” wc
    - Boiler 3 = -.2950” wc
  - Outside Outlet Pressure Req.

Pressure range - .2” to .24”
Proper System Design

- Common Venting of High Efficiency Appliances
  - Two Boilers Full - One off @ 0° outside temperature
    - Boiler 1 = -.1432” wc
    - Boiler 2 = -.1573” wc
    - Boiler 3 = -.3292” wc
  - How do you get Boiler 3 to ignite?

Pressure range - .2” to .24”
**Boiler Errors**

- **Ignition Failure**
  - Problem typically increases in cold weather at COLD STARTS and in warm weather.

- **Flame Failure**
  - Problem typically increases in cold weather typically occur in Lower Firing Rates.

- **Air Switch Not Open or Not Closed**
  - Problem typically increases in cold weather when cycling hot Boilers and in Sealed Combustion applications.
Proper System Design

- Locking Quadrant Dampers
  - Allow adjustment for Actual Conditions
    - Reduce draft by creating restriction
    - True Conditions vs. Draft Calculations
  - Will not Compensate
  - Limits Boiler Output
Proper System Design

- Barometric Dampers
  - Allow room air to balance vent
  - Works well on atmospheric systems
  - Category I and II systems
Proper System Design

- Draft Induction/Single Damper Approach
  - Allows stack to remain negative
    - Under all conditions
  - No control of pressure at outlet
    - Slow reaction time
  - Never able to obtain positive pressure
    - Downdraft unfired appliances
  - Achilles Heal
    - Fan down = entire system down
Proper System Design

- Draft Control
  - Actuating Dampers
    - Able to maintain correct outlet pressure
    - Low cost – compared to fans
Proper System Design

Sequence Draft Control

- Kaiser System Example
Summary – Take Control

✓ **Pressure Drop Calculations for ALL Systems**
  - Accounting for all conditions
  - For each appliance MFG

✓ **Outlet Pressure Control**

✓ **Provide a detailed system configuration**
  - Includes drains
  - Pressure control
  - Proper termination
  - **Must be followed to ensure pressure drop is accurate**

✓ **Detailed specifications**
  - **Only way to ensure proper operation**
Special Gas Venting Systems
Proper System Design for Category IV Appliances