Combustion Safety in the Codes

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Combustion Safety in the Codes

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Widely adopted fuel gas codes:

- **National Fuel Gas Code – ANSI Z223.1/NFPA 54, published by AGA and NFPA (NFGC)**
- **International Fuel Gas Code – published by the International Code Council (IFGC)**
- **Uniform Plumbing Code published by IAPMO (UPC)**

Safety codes become requirements when adopted by the Authority Having Jurisdiction (governments or fire safety authorities)

Combustion Safety in the Codes

Formal Relationships Between these codes:

- **– The IFGC extracts many safety requirements from the NFGC**
- **– The UPC adopts most safety requirements from the NFGC**

Ensures all three codes have the same requirements

Combustion Safety in the Codes

Scope:

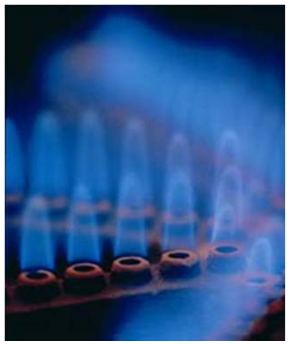
- **All installations of gas piping, appliances, equipment, and related accessories.**
- **After the point of delivery defined as the gas utility meter or second stage regulator for LP.**
- **Systems/Installations up to gas pressure of 125 psig**

NFGC/IFGC/UPC - FUNDAMENTAL SAFETY RELATED COVERAGE:

1. Gas piping: allowed materials, sizing, installation, inspection and testing
2. Appliance Installation: clearances to combustible materials, combustion air, and testing
3. Appliance venting: allowed materials, vent type selection, sizing, installation, and testing

Three Key Provisions For Combustion Safety

1. Combustion air requirements
2. Language on placing an appliance in operation
3. Vent sizing tables for atmospheric combustion and fan-assisted (Category I) equipment



General Combustion Air Supply:

Specified by appliance type:

- Natural draft and category I appliances:

  The code contains calculation methods for use of indoor air, outdoor air, or a combination.

- Other than natural draft and Category I appliances:

  In accordance with the manufacturers installation instructions.

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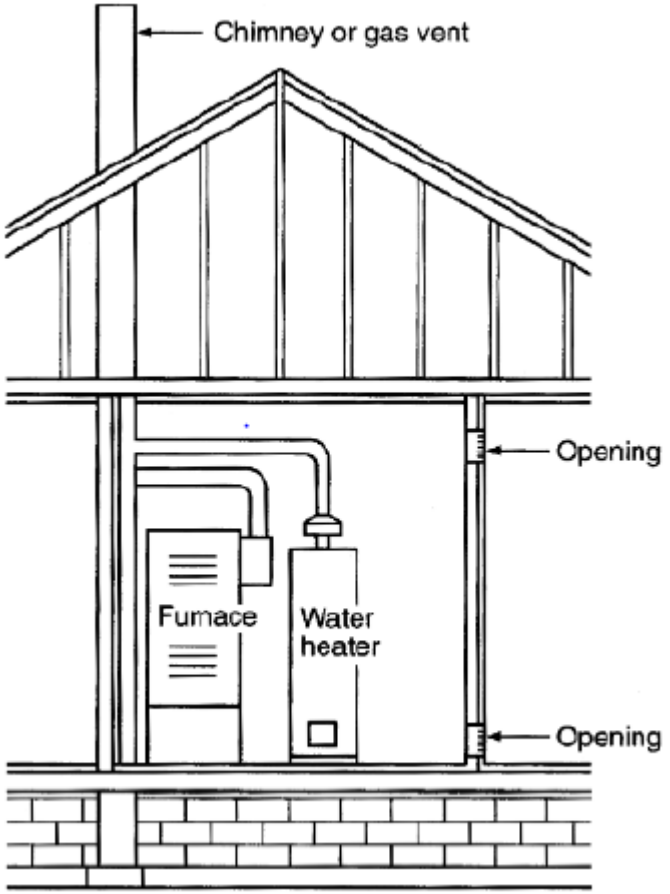
Allowed Combustion Air Sources:

- 100% Indoor air
- 100% Outdoor air
- Combination of Indoor/Outdoor air
- Mechanically supplied
- Engineered Systems



Indoor Combustion Air:

Two calculation methods:

- Where the infiltration rate is **unknown**:
  - 50 Cubic Feet (indoor building volume) per 1,000 Btu appliance input
  - Historical basis is 0.5 Air Change per Hour (ACH)
  - Assumes all appliances are natural draft (requires vent dilution air supply)

- Where the infiltration rate is **known** or is set by the local authority
  - Indoor volume is calculated based on the ACH and appliance type
  - Appliances are classified as either fan-assisted or other than fan assisted (Fan-assisted appliances do not require a vent dilution air supply)

Outdoor Combustion Air:

Where indoor air is insufficient the code requires the use of outdoor air:

- Outdoor openings are sized based on:
  - Appliance Btu input
  - Number of openings to be installed (one or two)
  - The opening is directly to the outdoors or through ducts

1. Combustion Air

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Combination Indoor/Outdoor Combustion Air:

- The size of the outdoor openings can be reduced where some indoor volume can be used.

Mechanical Combustion Air:

- A central ventilation air system is allowed to be used to supply combustion air
- System must provide in addition to all ventilation air a minimum of 0.35 cubic foot per minute for each 1,000 Btu/hr of appliance input
- System must be interlocked to the appliances

Engineered Combustion Air:

- Must be approved by the Authority Having Jurisdiction

2. Placing an Appliance in Operation

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2012 NFGC Section 11

Follow the manufacturers installation instructions.

1. **Adjust input (on rate and derate for high altitude)**
2. **Adjust primary air**
3. **Check safety shutoff devices**
4. **Check automatic ignition devices**
5. **Check limit controls**
6. **Check the draft**

2012 IFGC Section 305.1

Equipment and appliances shall be installed…according to the manufacturers installation instructions.

Appendix D (IFGC), Annex G (NFGC) - "Recommended Procedure for Safety Inspection of an Existing Appliance Installation"

Not a part of the code.

(Continued)

2. NFGC – 11.6 Check the Draft

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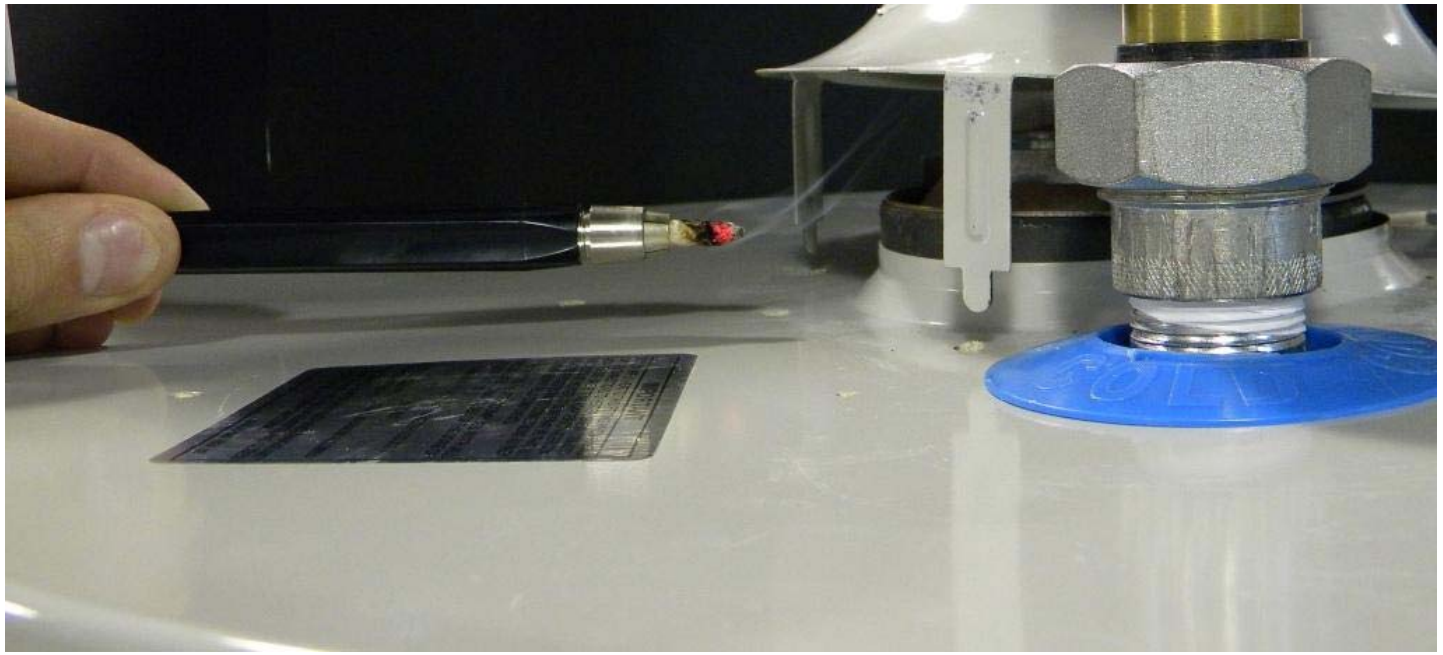
“Draft hood-equipped appliances shall be checked to verify that there is no draft hood spillage after 5 minutes of main burner operation.”

Failing the test fails the inspection and remediation is required.



National Fuel Gas Code 2012 Edition

2. Atmospheric Water Heater Manufacturers Installation Instructions (example)

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COMBUSTION AIR AND VENTILATION FOR APPLIANCES LOCATED IN UNCONFINED SPACES

UNCONFINED SPACE is space whose volume is not less than 50 cubic feet per 1,000 Btu per hour (4.8 cm per kW) of the aggregate input rating of all appliances installed in that space. Rooms communicating directly with the space in which the appliances are installed, through openings not furnished with doors, are considered a part of the unconfined space.

In unconfined spaces in buildings, infiltration may be adequate to provide air for combustion, ventilation and dilution of flue gases. However, in buildings of tight construction (for example, weather stripping, heavily insulated, caulked, vapor barrier, etc.), additional air may need to be provided using the methods described in "Combustion Air and Ventilation for Appliances Located in Confined Spaces."

COMBUSTION AIR AND VENTILATION FOR APPLIANCES LOCATED IN CONFINED SPACES

CONFINED SPACE is a space whose volume is less than 50 cubic feet per 1,000 Btu per hour (4.8 cm per kW) of the aggregate input rating of all appliances installed in that space.

A. ALL AIR FROM INSIDE BUILDINGS: (See Figure 4 and 5)

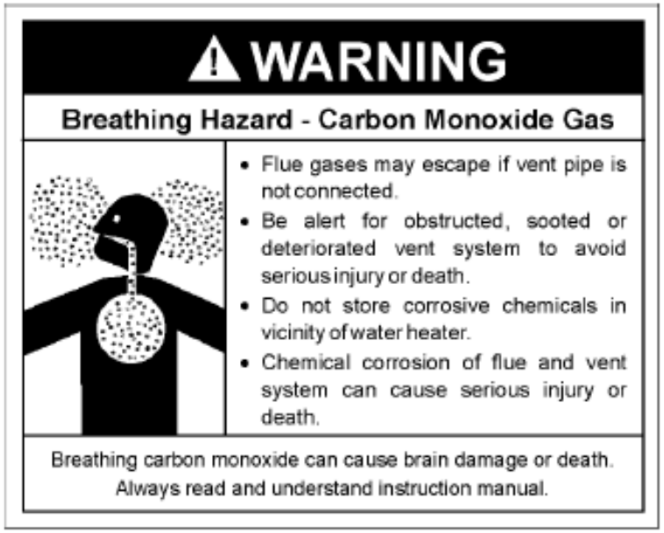
The confined space shall be provided with two permanent openings communicating directly with an additional room(s) of sufficient volume so that the combined volume of all spaces meets the criteria for an

START UP CONDITIONS

DRAFT HOOD OPERATION

Check draft hood operation by performing a worst case depressurization of the building. With all doors and windows closed, and with all air handling equipment and exhaust fans operating such as furnaces, clothes dryers, range hoods and bathroom fans, a match flame should still be drawn into the draft hood of the water heater with its burner firing. If the flame is not drawn toward the draft hood, shut off water heater and make necessary air supply changes to correct.

VENTING SYSTEM INSPECTION



At least once a year a visual inspection should be made of the venting system. You should look for:

1. Obstructions which could cause improper venting. The combustion and ventilation air flow must not be obstructed.

2. Damage or deterioration which could cause improper venting or leakage of combustion products.

3. Rusted flakes around top of water heater.

Be sure the vent piping is properly connected to prevent escape of dangerous flue gasses which could cause deadly asphyxiation.

Obstructions and deteriorated vent systems may present serious health risk or asphyxiation.

2. Procedures for Safety Inspection

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"This appendix is informative and not a part of the code."

Procedure is intended as a guide that an appliance is properly installed and in safe condition for continuing use. Intended for central furnaces and boilers.

1. Check for gas leaks
2. Inspect the vent for compliance to codes and deterioration
3. Shut off gas
4. Inspect burners and crossover tubing
5. Furnace – inspect heat exchanger
6. Boiler – inspect for leaks
7. Set up the house for test
    a. Close all doors and windows
    b. Turn on clothes dryers
    c. Turn on exhaust fans at max speed – range hoods and bathroom vents (not whole house fan)
    d. Close fireplace damper

2. Procedures for Safety Inspection

7. Place appliance in operation – set to operate continuously
8. Check pilot, main burner ignition, pilot sense device
9. Check main burner - no floating, lifting, flashback
10. **Test for spillage at the draft hood relief opening after 5 minutes of operation with match, candle, or smoke**
11. Turn on other appliances in the same room
12. Repeat steps 10-11 on appliance being inspected
13. Return building to previous condition
14. Furnace – check limit and fan control
15. Boiler – check safety devices

3. Venting Provisions

SELECTION OF VENTS:

- **Based on appliance operating parameters:**
  - **Natural draft or mechanically vented**
  - **The listed vent category for furnaces and boilers**
    - **I, II, III, or IV**

Types of Vents

- **Masonry, metal, and factory-built chimneys**
- **Gas Vents**
  - **Listed Type B & Type L**
  - **Vents specified by the manufacturer**

VENTING TABLES

- 15 Tables
- Applicable to natural draft appliances
  - –Includes Category I and fan assisted Category I appliances
  - – Typical storage-type water heaters, 78%-82% AFUE furnaces & boilers

Table 13.2(a) Type B Double-Wall Vent

Number of Appliances:	Two or More
Appliance Type:	Category I
Appliance Vent Connection:	Type B Double Wall Connector

Vent CONNECTOR Capacity

Height H (ft)	Connector Rise R (ft)	Type B Double-Wall Connector Diameter — D in.																			
		3			4			5			6			7			8			9			10		
		Appliance Input Rating Limits in Thousands of Btu per Hour																					
		FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	22	37	26	35	66	46	46	106	72	58	164	104	77	225	142	92	296	185	109	376	237	128	466	289
	2	23	41	31	37	75	55	48	121	86	60	183	124	79	253	168	95	333	220	112	424	282	131	526	345
	3	24	44	35	38	81	62	49	132	96	62	199	139	82	275	189	97	363	248	114	463	317	134	575	386
8	1	22	40	27	35	72	48	49	114	76	64	176	109	84	243	148	100	320	194	118	408	248	138	507	303
	2	23	44	32	36	80	57	51	128	90	66	195	129	86	269	175	103	356	230	121	454	294	141	564	358
	3	24	47	36	37	87	64	53	139	101	67	210	145	88	290	198	105	384	258	123	492	330	143	612	402
10	1	22	43	28	34	78	50	49	123	78	65	189	113	89	257	154	106	341	200	125	436	257	146	542	314
	2	23	47	33	36	86	59	51	136	93	67	206	134	91	282	182	109	374	238	128	479	305	149	596	372
	3	24	50	37	37	92	67	52	146	104	69	220	150	94	303	205	111	402	268	131	515	342	152	642	417
15	1	21	50	30	33	89	53	47	142	83	64	220	120	88	298	163	110	389	214	134	493	273	162	609	333

3. Venting Provisions

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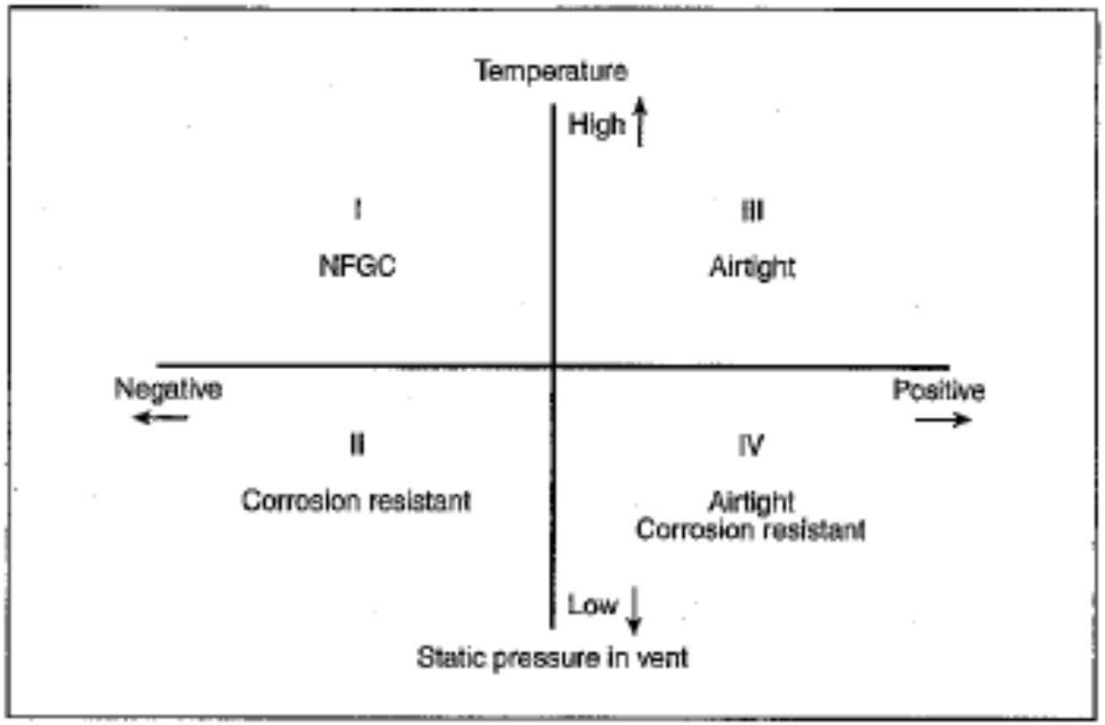
Vent systems other than Category I – refer to manufacturers installation instructions



Category IV furnace,
Category I water heater

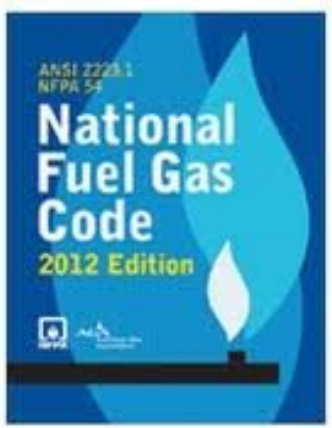
3. Venting Tables – Combustion Safety

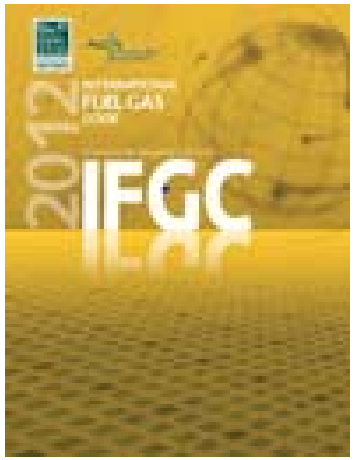
What combustion safety-related assumptions are behind the venting tables – FAN and NAT?

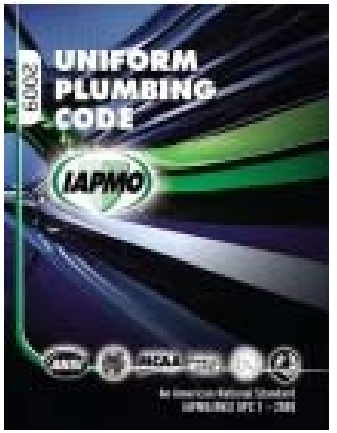
- **Minimum capacity – FAN only; governed by the wet-time rule to avoid corrosion failures.**
- **Maximum capacity – Governed by buoyancy requirements.**
  - **For FAN - Calculated based on zero static vent pressure 1 ft. from appliance outlet 1 minute from the start of the third appliance cycle. These systems also have vent safety switches.**
  - **For NAT, maximum capacity is based on venting tables originally published in the 1950's and supported by 60 years of field performance.**

All Codes

1. Required volume of combustion air as calculated
2. For draft hood equipped appliances: no spillage after 5 minutes of main burner operation. Recommended safety inspection. For fan-assisted appliances, tables are based on: zero static pressure one ft. from appliance outlet 1 minute into the third appliance cycle.
3. Vent installation consistent with the tables







Summary – Open Questions

- What is the basis for the combustion air calculations?
- What is the basis for checking performance of the draft hood after 5 minutes?
- Has anything changed to cause us to re-visit the assumptions behind the recommendations in the codes?

Gaps and Barriers in Combustion Safety

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Overall residential gaps/barriers addressed in this presentation:

Common Basis for Combustion Safety Recommendations

- Specifically, recommendations for tight houses

What have we achieved so far?

- This presentation sets the basis for combustion safety procedures in the National and International Fuel Gas Code.

- What is left to achieve?

- The highest priority issue remaining to be solved is disconnect between code language, manufacturer installation instructions, and recommendations by field inspectors.
- We plan to continue to close this gap by identifying the differences between recommendations and seeking common ground.
- Possible risks going forward include differing recommendations not based on building science research.

Combustion Safety Expert Meeting

Expert Meeting

U.S. Department of Energy, Energy Efficiency and Renewables, Building America Program

Partnership for Advanced Residential Retrofit (PARR)

PARR
The Partnership for Advanced Residential Retrofit

Topic: "Combustion Safety in Tight Houses"

When: Thursday June 28, 2012; 9 a.m. to 3 p.m. Central, (post-ASHRAE)

Where: CPS Energy Board Room (Address), San Antonio Texas

Dial-in Number: *NREL Live Webinar*

Description: : The Department of Energy Building America program focuses on reducing energy consumption in the nation's housing stock through smart application of energy efficient design and whole-house upgrades. The target is a 30% energy savings captured through application of many measures including reduction in air infiltration, equipment upgrades, and thermal envelope losses. Combustion safety testing is an important part of the test-in and test-out process in new construction and retrofit (upgrade) projects when houses are being tightened to reduce energy losses through air infiltration. Where combustion safety testing identifies excessive spillage or continuous back-drafting, remedial measures are required.