ENERGY SOLUTIONS CENTER

Track: Natural Gas Basics
Unit 9: Building Codes & Fuel Switching

Eric Burgis, Energy Solutions Center

Presentation Outline

- Codes and Standards
- Gas piping – piping materials, joints, and general sizing criteria
- Venting – venting system types and sizing
- Appliance conversions – propane and oil
- Resources

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Codes & Standards

Code Requirements

- Safety first
  - Individual utility requirements – check SOP Manual for any specific code requirements
  - Local or State Codes
  - National Gas Codes

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Basic Requirement

- Any conversion will need to meet all fuel gas installation requirements of the current code
- Current Propane Users – May be able convert appliances, reuse piping, and vents
- Current Oil Users – May be able to convert boiler/furnace and use existing chimney

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Gas Piping & Materials

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Allowed Gas Piping

- Scheduled 40 Wrought Iron, Steel (Black Pipe) or galvanized steel
- Corrugated Stainless Steel Tubing (CSST)
  - Two types CSST: yellow clad, and arc-resistant (jacketed)
- Copper provided gas contains less than .3 grains of hydrogen sulfide per 100 scf (.7 mg/100 L)
- Polyethylene (underground and outside only)

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Fittings

- Scheduled 40 Wrought Iron, Steel (Black Pipe), Galvanized Steel – Threaded up to 4”, welded greater than 4”
- CSST – Fittings provided by manufacturer
- Polyethylene – Risers & Transition fittings
- Press-Connect fittings for steel & copper
  - (Must comply with CSA LC-4)

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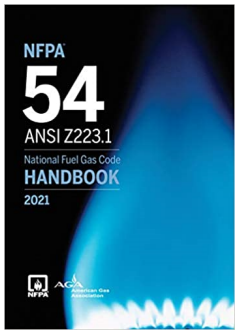
Pipe Sizing

- For steel pipe – NFPA sizing tables, state gas codes or utility piping schedules
- CSST – Manufacturers specifications or local jurisdiction



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Pipe Sizing Tables

Table 6.2.1(b) Schedule 40 Metallic Pipe

Gas	Natural
Inlet pressure	Less than 2 psi
Pressure Drop	0.5 in. w.c.
Specific Gravity	0.60

Pipe Size (in.)													
Nominal:	½	¾	1	1¼	1½	2	2½	3	4	5	6	8	10	12
Actual ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	Capacity in Cubic Feet of Gas per Hour													
10	172	360	678	1,390	2,090	4,020	6,400	11,300	23,100	41,800	67,600	139,000	252,000	399,000
20	118	247	466	957	1,430	2,760	4,400	7,780	15,900	28,700	46,500	95,500	173,000	275,000
30	95	199	374	768	1,150	2,220	3,530	6,250	12,700	23,000	37,300	76,700	139,000	220,000
40	81	170	320	657	985	1,900	3,020	5,350	10,900	19,700	31,900	65,600	119,000	189,000
50	72	151	284	583	873	1,680	2,680	4,740	9,660	17,500	28,300	58,200	106,000	167,000
60	65	137	257	528	791	1,520	2,430	4,290	8,760	15,800	25,600	52,700	95,700	152,000

Table 6.2.1(i) Semirigid Copper Tubing

Gas	Natural
Inlet pressure	Less than 2 psi
Pressure Drop	0.5 in. w.c.
Specific Gravity	0.60

Tube Size (in.)									
Nominal:	K & L	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR	⅜	½	⅝	¾	⅞	1⅛	1⅜	–	–
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside:		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)	Capacity in Cubic Feet of Gas per Hour									
10		27	55	111	195	276	590	1,060	1,680	3,490
20		18	38	77	134	190	406	730	1,150	2,400
30		15	30	61	107	152	326	586	925	1,930
40		13	26	53	92	131	279	502	791	1,650
50		11	23	47	82	116	247	445	701	1,460
60		10	21	42	74	105	224	403	635	1,320

Table 6.2.1(o) Corrugated Stainless Steel Tubing (CSST)

Gas	Natural
Inlet pressure	Less than 2 psi
Pressure Drop	0.5 in. w.c.
Specific Gravity	0.60

Tube Size (EHD)														
Flow Designation:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
Length (ft)	Capacity in Cubic Feet of Gas per Hour													
5	46	63	115	134	225	270	471	546	895	1,037	1,790	2,070	3,660	4,140
10	32	44	82	95	161	192	330	383	639	746	1,260	1,470	2,600	2,930
15	25	35	66	77	132	157	267	310	524	615	1,030	1,200	2,140	2,400
20	22	31	58	67	116	137	231	269	456	536	888	1,050	1,850	2,080

Table 6.2.1(u) Polyethylene Plastic Pipe

Gas	Natural
Inlet pressure	Less than 2 psi
Pressure Drop	0.5 in. w.c.
Specific Gravity	0.60

Pipe Size (in.)								
Nominal OD:	½	¾	1	1¼	1½	2	3	4
Designation:	SDR 9.3	SDR 11	SDR 11	SDR 10	SDR 11	SDR 11	SDR 11	SDR 11
Actual ID:	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
Length (ft)	Capacity in Cubic Feet of Gas per Hour							
10	201	403	726	1,260	1,900	3,410	9,450	18,260
20	138	277	499	865	1,310	2,350	6,490	12,550
30	111	222	401	695	1,050	1,880	5,210	10,080
40	95	190	343	594	898	1,610	4,460	8,630
50	84	169	304	527	796	1,430	3,950	7,640
60	76	153	276	477	721	1,300	3,580	6,930

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What's Needed

- Total BTU of installed appliances
- Total pipe length from the outlet of the meter to the furthermost appliance
- System pressure (in. w.c. or PSI)
- Piping material

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Sizing Pipe for Propane Conversion

- Reuse pipe without modification if sizing is adequate
- Change out if local LDC does not allow copper fuel line for natural gas.
  - Note that the Fuel Gas Code requires that natural gas contain less than .3 grains of hydrogen sulfide per 100 scf (.7 mg/100 L) for use with copper piping. Pipeline quality natural gas is below this level.

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Venting

Appliance Categories
(Cat I & IV available for boilers, furnaces, and storage water heaters)

- **Category I:** An appliance that operates with non-positive vent static pressure and with vent gas temperature that avoids excessive condensate production in the vent (Atmospheric)
- **Category II:** An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent (technically infeasible)

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Appliance Categories…..continued

- **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
- **Category IV:** An appliance that operates with a positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

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Type of Venting Systems

Table 12.5.1 Type of Venting System to Be Used.

Appliances	Type of Venting System	Location of Requirements
Listed Category I appliances	Type B gas vent	12.7
Listed appliances equipped with draft hood	Chimney	12.6
Appliances listed for use with Type B gas vent	Single-wall metal pipe	12.8
	Listed Chimney lining system for gas venting	12.6.1.3
	Special Gas Vent listed for these appliances	12.5.4
Listed vented wall furnaces	Type B-W gas vent	12.7, 10.25
Category II, Category III, and Category IV appliances	As specified or furnished by manufacturers of listed appliances	12.5.2, 12.5.4

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Typical Venting Systems

- Lined masonry chimney – natural draft atmospheric appliances
- Type B – natural draft atmospheric appliances
- Plastic – most condensing appliances



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Exposed Masonry Chimneys

- Can be used for gas appliances only if relined with a liner system or B-Type vent is installed
- Use chimney as a chase


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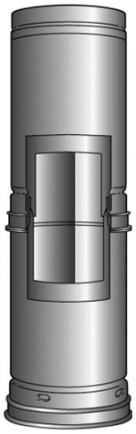
Type-B Double-Wall Gas Vents

- Has an aluminum inner wall and a galvanized steel outer wall
- The double-wall, air insulated design keeps the flue gases hot inside the vent, while maintaining a cool outside wall temperature
- Provides a strong draft with minimal condensation and permits the vent to be installed with a 1-inch clearance to nearby combustibles



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Type-B Double-Wall Gas Vents

- The aluminum inner wall heats up rapidly because the aluminum has a low mass and high thermal conductivity, presenting a warm surface to the vent gases
- Condensation forms only briefly on the vent walls, which reduces the wet time and the potential for corrosion
- The aluminum inner wall is corrosion resistant to condensation that may form in the vent, which provides a safe, long lasting installation

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Using Existing Chimneys and Vents

- Match load – resized for new use
- Existing chimney must be examined to determine if it is in good shape and properly lined
- Cleaned if previously used for oil or solid fuel and terracotta lined. (If not lined the masonry chimney requires a liner before it can be used for natural gas if previously used for oil.)

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Proper Sizing of Exhaust

- Natural draft type: Venting tables
- Fan-Assisted Category I appliances (e.g. 80% AFUE) use the venting tables
- Condensing Appliances (e.g. 90+ AFUE) & Direct Vent use the manufacturer's instructions

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Sizing Tables

- Sizing tables should be viewed as a basic tool for the design of venting systems that provides valuable information on how four key factors impact each other:
  - The **BTU rating** of the appliance, the **height** of the vent, the **length** of any lateral runs, and the **diameter** of the vent
  - If any three factors are known, the sizing table will indicate what the fourth factor should be

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Sizing Tables

Table 13.1(a) Type B Double-Wall Gas Vent

Number of Appliances:	Single
Appliance Type:	Category I
Appliance Vent Connection:	Connected Directly to Vent

Height H (ft)	Lateral L (ft)	Vent Diameter — D in. 3 FAN Min	3 FAN Max	3 NAT Max	4 FAN Min	4 FAN Max	4 NAT Max	5 FAN Min	5 FAN Max	5 NAT Max	6 FAN Min	6 FAN Max	6 NAT Max	7 FAN Min	7 FAN Max	7 NAT Max	8 FAN Min	8 FAN Max	8 NAT Max	9 FAN Min	9 FAN Max	9 NAT Max
		Appliance Input Rating in Thousands of Btu per Hour																				
6	0	0	78	46	0	152	86	0	251	141	0	375	205	0	524	285	0	698	370	0	897	470
	2	13	51	36	18	97	67	27	157	105	32	232	157	44	321	217	53	425	285	63	543	370
	4	21	49	34	30	94	64	39	153	103	50	227	153	66	316	211	79	419	279	93	536	362
	6	25	46	32	36	91	61	47	149	100	59	223	149	78	310	205						
8	0	0	84	50	0	165	94	0	276	155	0	415	235	0	583	320						
	2	12	57	40	16	109	75	25	178	120	28	263	180	42	365	247						
	5	23	53	38	32	103	71	42	171	115	53	255	173	70	356	237						
	8	28	49	35	39	98	66	51	164	109	64	247	165	84	347	227						

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

Vent Height H (ft)	Connector Rise R (ft)	Type B Double-Wall Connector Diameter — D in. 3 FAN Min	3 FAN Max	3 NAT Max	4 FAN Min	4 FAN Max	4 NAT Max	5 FAN Min	5 FAN Max	5 NAT Max	6 FAN Min	6 FAN Max	6 NAT Max	7 FAN Min	7 FAN Max	7 NAT Max	8 FAN Min	8 FAN Max	8 NAT Max	9 FAN Min	9 FAN Max	9 NAT Max	10 FAN Min	10 FAN Max	10 NAT Max
		Appliance Input Rating Limits in Thousands of Btu per Hour																							
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

NFPA 54

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Natural Draft Appliances – Vent Sizing

- The vent and connector diameters are located across the top of the tables and the list of BTU's under the columns entitled "NAT MAX"
- The BTU values indicate the maximum volume of gas (BTU's) that can be vented through a given vent diameter

Table 13.1(e) Single Wall Metal Pipe or Type B Asbestos Cement Vent

Number of Appliances:	Single
Appliance Type:	Draft Hood-Equipped
Appliance Vent Connection:	Connected Directly to Pipe or Vent

Height H (ft)	Lateral L (ft)	Vent Diameter — D in.							
		3	4	5	6	7	8	10	12
		Appliance Input Rating in Thousands of Btu per Hour							
6	0	39	70	116	170	232	312	500	750
	2	31	55	94	141	194	260	415	620
	5	28	51	88	128	177	242	390	600
8	0	42	76	126	185	252	340	542	815
	2	32	61	102	154	210	284	451	680
	5	29	56	95	141	194	264	430	648
	10	24	49	86	131	180	250	406	625

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Natural Draft Appliances – Vent Sizing

- The second factor that determines the size of a vent system is the total height of the vent
- Locate the height column on the far left of the sizing chart
- For any given vent diameter, the greater the height of the vent, the greater the BTU capacity of the venting system

Table 13.1(e) Single Wall Metal Pipe or Type B Asbestos Cement Vent

Number of Appliances:	Single
Appliance Type:	Draft Hood-Equipped
Appliance Vent Connection:	Connected Directly to Pipe or Vent

Height H (ft)	Lateral L (ft)	Vent Diameter — D in.							
		3	4	5	6	7	8	10	12
		Appliance Input Rating in Thousands of Btu per Hour							
6	0	39	70	116	170	232	312	500	750
	2	31	55	94	141	194	260	415	620
	5	28	51	88	128	177	242	390	600
8	0	42	76	126	185	252	340	542	815
	2	32	61	102	154	210	284	451	680
	5	29	56	95	141	194	264	430	648
	10	24	49	86	131	180	250	406	625

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Natural Draft Appliances – Vent Sizing

- The third factor that determines the size of the vent is the length of any horizontal (lateral) runs
- Since hot flue gas attempts to flow straight up, a lateral run of vent pipe serves as a restriction
- By eliminating long lateral runs in the venting system a less expensive, smaller diameter vent may be used on the same BTU appliance

Table 13.1(e) Single Wall Metal Pipe or Type B Asbestos Cement Vent

Number of Appliances:	Single
Appliance Type:	Draft Hood-Equipped
Appliance Vent Connection:	Connected Directly to Pipe or Vent

Height H (ft)	Lateral L (ft)	Vent Diameter — D in.							
		3	4	5	6	7	8	10	12
		Appliance Input Rating in Thousands of Btu per Hour							
6	0	39	70	116	170	232	312	500	750
	2	31	55	94	141	194	260	415	620
	5	28	51	88	128	177	242	390	600
8	0	42	76	126	185	252	340	542	815
	2	32	61	102	154	210	284	451	680
	5	29	56	95	141	194	264	430	648
	10	24	49	86	131	180	250	406	625

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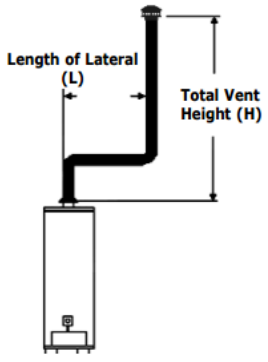
How to Size

- Determine the Total Vent Height and length of lateral as shown in the appropriate table
- Find a height equal to or less than the total height of the installation in the table
- Select the horizontal row for the appropriate Lateral (L) length
- For natural draft appliances, read across to the first column under NAT Max, which has a BTU capacity equal to or greater than the nameplate sea level input rating of the appliance
- The proper vent size is shown at the top of the column



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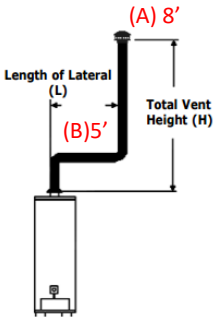
Sizing Example



(C) 40,000 BTU Water Heater

Table 13.1(e) Single Wall Metal Pipe or Type B Asbestos Cement Vent

Number of Appliances:	Single
Appliance Type:	Draft Hood-Equipped
Appliance Vent Connection:	Connected Directly to Pipe or Vent

Height H (ft)	Lateral L (ft)	Vent Diameter — D in.							
		3	4	5	6	7	8	10	12
		Appliance Input Rating in Thousands of Btu per Hour							
6	0	39	70	116	170	232	312	500	750
	2	31	55	94	141	194	260	415	620
	5	28	51	88	128	177	242	390	600
8	0	42	76	126	185	252	340	542	815
A	2	32	61	102	154	210	284	451	680
	5B	29	56C	95	141	194	264	430	648
	10	24	49	86	131	180	250	406	625
10	0	45	84	138	202	279	372	606	912
	2	35	67	111	168	233	311	505	760
	5	32	61	104	153	215	289	480	724
	10	27	54	94	143	200	274	455	700
	15	NA	46	84	130	186	258	432	666
15	0	49	91	151	223	312	420	684	1040
	2	39	72	122	186	260	350	570	865

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Fan Assisted Appliances

- The sizing tables for fan-assisted appliances are very similar to the tables used for natural draft-appliances
- The only difference is a new column entitled FAN MIN/MAX
- The purpose of the FAN MIN column is to determine if a sufficient amount of heat (BTU's) is flowing into the vent in order to minimize condensation and also to quickly dry up any condensation that does form

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

Vent 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	285
	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	353
	3	24	47	36	37	87	64	53	139	101	67	210	145	88	290	198	105	384	258	123	492	330	143	612	403

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Fan Assisted Appliances

- For fan-assisted appliances; it is very important that the appliance BTU input rating falls between the FAN MIN and the FAN MAX
- If the BTU input rating is less than the FAN MIN, condensation may occur
- If the BTU input rating is greater than the FAN MAX, the flue gas may backup and cause the vent system to become pressurized

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Fan Assisted Sizing

- For fan-assisted appliances, read across to the first column under FAN Min/Max which has a Min value greater than or equal to the appliance input rating, and a Max value less than or equal to the appliance input rating
- The appliance input rating must fit within the Min and Max limits
- The proper vent size is shown at the top of the column

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

Vent 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 Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT 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	285
	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

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Common Vent Systems

- A common vent system refers to an installation of two or more gas appliances, installed on the same floor level, that are each connected to a common vent
- The vent connector sizing tables for common vent installations are quite similar to the sizing tables for single appliance installations

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Common Vent Systems

- There are two important differences when sizing vent connectors for common vented appliances:
  - **First**, which vent height is used when one appliance is taller than the other?
    - To be on the conservative side, use the vent height measured from the taller appliance
    - Since the taller appliance will have the least total height, it is important to size the venting system to insure that the taller appliance will draft properly
    - Use the least total height when sizing vent connectors for both the tall and short appliances

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Common Vent Systems

- There are two important differences when sizing vent connectors for common vented appliances:
  - The **second** difference in the vent connector tables for common vented appliances is the concern with the vertical height of the connector rise – the distance between the appliance flue outlet and the level at which the connector joins the common vent
    - This is important because the greater the connector rise, the stronger the draft

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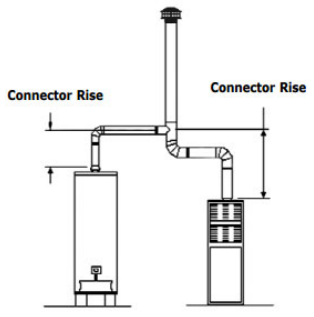
Common Vent Diagram & Table

Common VENT Capacity

Vent Height H (ft)	Type B Double-Wall Common Vent Diameter — D in.																				
	4			5			6			7			8			9			10		
	Combined Appliance Input Rating in Thousands of Btu per Hour																				
	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	92	81	65	140	116	103	204	161	147	309	248	200	404	314	260	547	434	335	672	520	410
8	101	90	73	155	129	114	224	178	163	339	275	223	444	348	290	602	480	378	740	577	465
10	110	97	79	169	141	124	243	194	178	367	299	242	477	377	315	649	522	405	800	627	495
15	125	112	91	195	164	144	283	228	206	427	352	280	556	444	365	753	612	465	924	733	565
20	136	123	102	215	183	160	314	255	229	475	394	310	621	499	405	842	688	523	1035	826	640
30	152	138	118	244	210	185	361	297	266	547	459	360	720	585	470	979	808	605	1209	975	740
50	167	153	134	279	244	214	421	353	310	641	547	423	854	706	550	1164	977	705	1451	1188	860
100	175	163	NA	311	277	NA	489	421	NA	751	658	479	1025	873	625	1408	1215	800	1784	1502	975



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Sizing Notes

- It is very important to follow all of the rules and vent requirements for proper sizing
- The sizing tables **do not** take into consideration many of the special circumstances that can significantly change the values listed in the tables
- The tables assume that only two 90° elbows are used in the entire vent system
- When more than two 90° elbows are used, the maximum capacity values listed in the sizing tables must be reduced by 10% for each additional 90° elbow, or equivalent

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Alternate Sizing Method

- Prior to the introduction of fan-assisted gas appliances, installers typically relied on the "Alternate Sizing Method" for designing venting system
- The installer simply sized the vent to the size of the appliance flue outlet
- While this method was very simple, it failed to take into account important factors such as the total height of the vent, length of lateral runs, number of elbows, etc.
- As a result, this sizing method often resulted in improperly sized installations and, in some cases, vent designs that could have been more cost effective

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Alternate Sizing Method

- Today, with the introduction of "near condensing" fan-assisted gas appliances and higher efficiency levels for draft hood-equipped appliances, proper sizing has become far more critical and less forgiving
- The National Fuel Gas Code now restricts the use of the Alternate Sizing Method to Category I draft hood-equipped appliances only
- Fan-assisted appliances must be sized using the vent tables

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When In Doubt

- **Use one size larger**
- It is not possible to anticipate all contingencies in designing a vent system
- If there is concern that the vent may not function properly due to a short connector rise, excessive number of elbows, long lateral runs, etc., the next larger size vent connector should be selected
- Be sure to increase the connector size all the way down to the appliance outlet, even if the appliance outlet size is smaller than the vent
- By increasing the vent connector size, the risk of draft hood spillage or positive pressure problems will be avoided

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Roof Terminations

- Type B Gas Vent caps should terminate in accordance with these dimensions in mind

Item	Clearances	Maximum Height	Outer Tube Ø	Materials	Locking Device	UL Listing	ULC Listing
Type B Vent Round 3"-8"	1 inch to combustibles	100 feet	¼" larger than ID	Inner - .012" Aluminum Outer - .018" Galvanized	DuraLock	MH6357	CMH1276
Round 10" to 16" See note 2	1 inch to combustibles	100 feet	1" larger than ID	Inner - .016" Aluminum Outer - .021" Galvanized	TwistLock Screws	MH6357	CMH1276
Round 18" to 30"	1 inch to combustibles	100 feet	2" larger than ID See note 5	Inner - .020" Aluminum Outer - .021" Galvanized	Screws	MH6357	CMH1276
Oval Type B Vent 4" and 5"	2" x 4" & 2" x 6" stud wall and 1 inch to combustibles	See Note 3	2 ½" x 7 ¼" 3 ⅛" x 10 ⅜"	Inner - .012" Aluminum Outer - .018" Galvanized	Button Lock	MH6357	CMH1276
Oval Type B Vent 6"	2" x 6" stud wall and 1 inch to combustibles	See Note 3	3 ¼" x 12"	Inner - .012" Aluminum Outer - .018" Galvanized	Button Lock	MH6357	CMH1276
Type B Vent 3" to 6" Round Liner	0"/Masonry	50 feet	⅛" larger than ID	Inner - .012" Aluminum Outer - .018" Galvanized	DuraLock	MH14420 MH6357	CMH1407
DuraFlex AL Gas Relining 3" to 6"	0"/Masonry	50 feet	¼" larger than ID	.010" Aluminum Flex	Screws DuraLock	MH14420	--
DuraConnect 3" to 6"	1 inch to combustibles	See Note 4	¼" larger than ID	.010" Aluminum Flex .018" Galvalume	DuraLock	MH14089	--
DuraConnect II 3" to 6"	1 inch to combustibles	See Note 4	¼" larger than ID	.010" Aluminum Flex .018" Galvalume	DuraLock	MH14089	--

NOTES

1. Clearance to combustibles is the air space between vent and combustibles.
2. Maximum height varies with equipment over 50', for taller applications refer to SDV sizing handbook (L202). 14"-16" Pipe require screws.
3. When oval is used on wall furnaces, minimum height required from bottom of furnace to cap is 12', minimum 16" stud space.
4. Limited by sizing tables.
5. 18" pipe OD is one inch larger than ID and 20" - 30" OD is 2" greater than ID.

	Minimum Height	
Roof Pitch	Feet	Meters
Flat to 7/12	1	0.30
Over 7/12 to 8/12	1.5	0.46
Over 8/12 to 9/12	2	0.61
Over 9/12 to 10/12	2.5	0.76
Over 10/12 to 11/12	3.25	0.99
Over 11/12 to 12/12	4	1.22
Over 12/12 to 14/12	5	1.52
Over 14/12 to 16/12	6	1.83
Over 16/12 to 18/12	7	2.13
Over 18/12 to 20/12	7.5	2.29
Over 20/12 to 21/12	8	2.44

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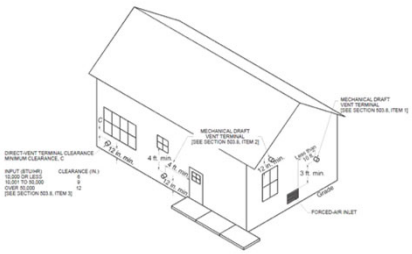
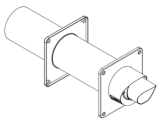
Vent Terminations

- All vents must be installed observing local regulations in addition to National Codes, CCSA-B149.1 or CCSA-B149.2 (for installations in Canada) or ANSI-Z223.1 - NFPA 54 (for installations in the U.S.A.)





Side Wall Exhausts

Roof Exhausts

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Appliance Conversions

Can Appliances be Converted

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Appliance Conversion Rules

- Appliances shall not be converted to utilize a different fuel gas except where complete instructions for such conversion are provided in the installation instructions, by the appliance manufacturer.
- Manufacturers are most knowledgeable about what needs to be done to convert their appliance.

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Converting from Propane

- Typically an orifice and control valve assembly change for furnace, boiler, range, or dryer.
  - Propane water heaters are a more complicated conversion and replacement is sometimes a better option.

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Converting from Oil

- Typically requires a burner change out using a qualified conversion burner

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Things to Consider Before Converting

- Age of appliance
- Availability of adequate instructions/parts
- Current appliance efficiency
- Vent/Chimney condition for reuse
- Overall cost versus new appliance purchase and install

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Typical Conversion Appliances

- Propane: Cooking appliances, dryer, fireplace appliances, and barbecues



- Oil: Boilers, Furnaces, and occasionally water heaters

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Combustion Air

- Combustion air is necessary for burning fuel such as gas, oil and wood.
- Furnaces need both combustion air and dilution air. The requirements are about 15 cubic feet of combustion air and 15 cubic feet of dilution air for every cubic foot of gas burned.

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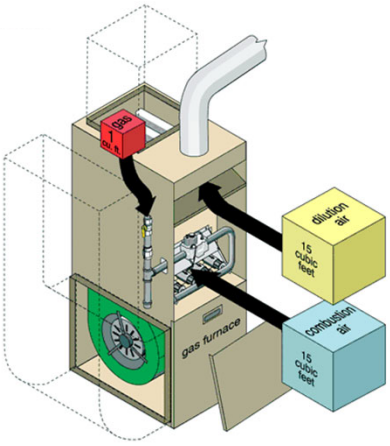
Combustion Air



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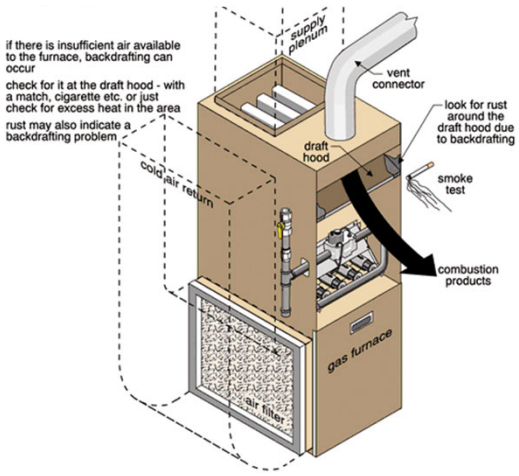
Backdrafting



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Backdrafting

- The implications of inadequate combustion and dilution air are significant
- The incomplete combustion process will generate carbon monoxide (the poisonous gas)
- The lack of dilution air is likely to result of backdraft – this means that combustion products can't go up the chimney but are dumped back into the room, which is under low pressure (since it's starved for air, because we've pulled all the air into the furnace for the combustion and dilution process)
- Backdrafting is also called spillage

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Combustion Air Options

- 100% Indoor Air – building infiltration is adequate to supply combustion air
- 100% Outdoor Air – opening to the outdoors where infiltration is inadequate
- Indoor/Outdoor – which permits smaller outdoor openings in some cases

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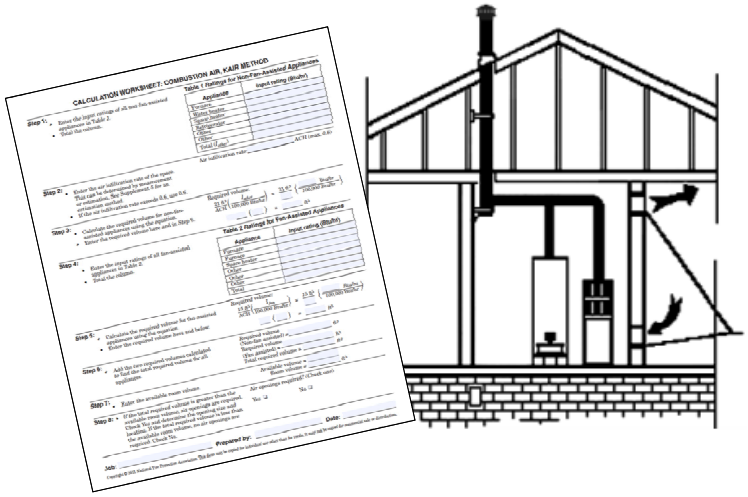
Using 100% Indoor Air

- Two Options:
  - Standard Method
  - KAIR Method



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Standard Method

- Indoor Combustion Air – The required volume of indoor air shall be determined in accordance with method 9.3.2.1 or 9.3.2.2 except that where the air infiltration rate is know to be less than 0.40 Air Changes per Hour (ACH), the method 9.3.2.2 shall be used
- The minimum required volume shall be 50 ft^3 per 1,000 Btu/hr (4.8 m3/kW)
- Method based on 0.50 ACH

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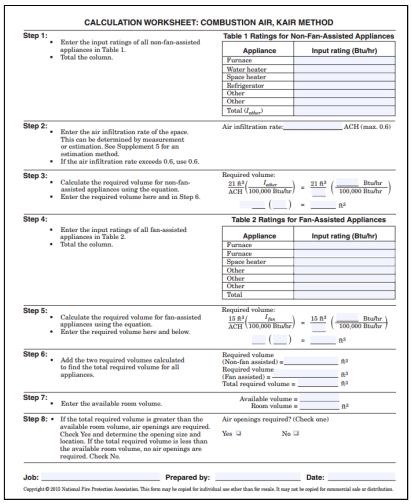
KAIR Method

Known Air Infiltration Rate



CALCULATION WORKSHEET: COMBUSTION AIR, KAIR METHOD

Step 1:
- Enter the input ratings of all non-fan-assisted appliances in Table 1.
- Total the column.

Table 1 Ratings for Non-Fan-Assisted Appliances

Appliance	Input rating (Btu/hr)
Furnace	
Water heater	
Space heater	
Refrigerator	
Other	
Other	
Total (I_{other})	

Step 2:
- Enter the air infiltration rate of the space. This can be determined by measurement or estimation. See Supplement 5 for an estimation method.
- If the air infiltration rate exceeds 0.6, use 0.6.

Air infiltration rate: _____ ACH (max. 0.6)

Step 3:
- Calculate the required volume for non-fan-assisted appliances using the equation.
- Enter the required volume here and in Step 6.

Required volume:

$\frac{21\ ft^3}{ACH}\left(\frac{I_{other}}{100{,}000\ Btu/hr}\right) = \frac{21\ ft^3}{\_\_\_}\left(\frac{\_\_\_\_\_\ Btu/hr}{100{,}000\ Btu/hr}\right)$

___ (___) = _____ ft^3

Step 4:
- Enter the input ratings of all fan-assisted appliances in Table 2.
- Total the column.

Table 2 Ratings for Fan-Assisted Appliances

Appliance	Input rating (Btu/hr)
Furnace	
Furnace	
Space heater	
Other	
Other	
Other	
Total	

Step 5:
- Calculate the required volume for fan-assisted appliances using the equation.
- Enter the required volume here and below.

Required volume:

$\frac{15\ ft^3}{ACH}\left(\frac{I_{fan}}{100{,}000\ Btu/hr}\right) = \frac{15\ ft^3}{\_\_\_}\left(\frac{\_\_\_\_\_\ Btu/hr}{100{,}000\ Btu/hr}\right)$

___ (___) = _____ ft^3

Step 6:
- Add the two required volumes calculated to find the total required volume for all appliances.

Required volume
(Non-fan assisted) = _____ ft^3
Required volume
(Fan assisted) = _____ ft^3
Total required volume = _____ ft^3

Step 7:
- Enter the available room volume.

Available volume = _____
Room volume = _____ ft^3

Step 8:
- If the total required volume is greater than the available room volume, air openings are required. Check Yes and determine the opening size and location. If the total required volume is less than the available room volume, no air openings are required. Check No.

Air openings required? (Check one)
Yes ❑ No ❑

Job: _____ Prepared by: _____ Date: _____

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KAIR Method

- KAIR Method must be used if 0.40 ACH and lower
- Calculations based on ACH and whether the appliance is fan-assisted or has a draft hood
- Fan-assisted found to require less air – no dilution air
- Upper ACH limit on use of KAIR method is 0.60

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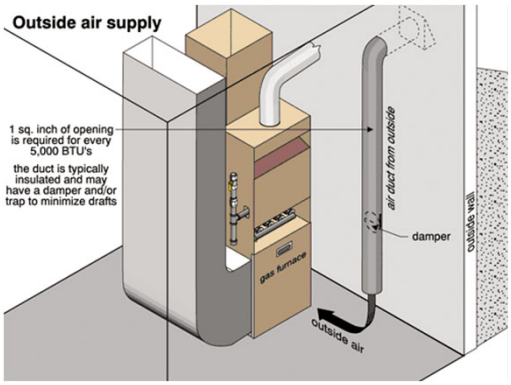
100% Outdoor Air

- One or two permanent openings



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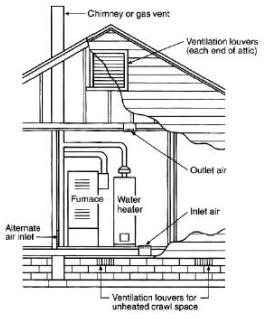
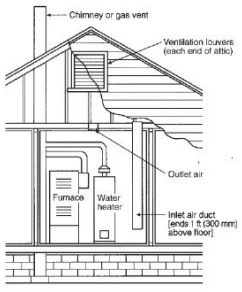
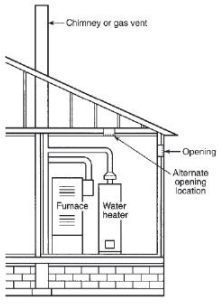
Outdoor Air Examples







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Resources

Associations & Resources

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  - Consortium of utility companies
  - www.escenter.org

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Associations & Resources

- AGA – American Gas Association
  - Located in Washington, DC
  - Trade association for utility companies
  - Helps develop Codes and Standards
  - www.aga.org

AGA
American Gas Association

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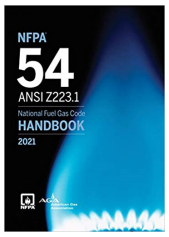
Associations & Resources

- National Fire Protection Association
- NFPA develops, publishes, and disseminates more than 300 consensus codes and standards
- More than 65,000 individual members
- Authors NFPA 54: National Fuel Gas Code
- www.nfpa.org



National Fire Protection Association
The authority on fire, electrical, and building safety

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Associations & Resources

- International Code Council
- A member-focused association dedicated to developing model codes and standards used in the design, build and compliance process to construct safe, sustainable, affordable and resilient structures
- Located in Washington, DC
- www.iccsafe.org

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Additional References

- Simpson Dura-Vent Sizing Handbook
- Dura-Vent Type B Gas Vent Systems

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