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VISUAL VENT

Venting Modern Heating Appliances

by
Michael Beisheim
VentBOM Visual Vent

Michael has more than 25 years of experience with Venting. This includes development of patented Draft Controls. His Design Software has been used on 130,000+ project designs worldwide. Contributor to both ASHRAE Handbooks and the European EN-13384 standards for venting. Now operating as completely Industry Neutral

VentBOM:

- Founded in 2006
- Used by nearly all vent manufacturers in North America
- Processed 400M+ in vent quotations last year

Visual Vent:

- Added in 2016
- Calculation/Simulation module
- Database for many types of equipment
- Currently in BETA test

Today's topics:

- Appliance Venting Categories
- Available Design Methods
- Basic theory of draft and flow
- Available Venting Products

Why bother?

"Just leave the vent design to the venting guys"

"We common-vent appliances all the time. Never have any problems"

CSA-B149:

Δ 8.10.6

An appliance that operates at a positive vent pressure shall not be connected to a venting system serving any other appliance (common vent), except for cases in which all of the following conditions are met:

(a) All the appliances sharing the vent are of the same type and manufacturer.

(b) All the appliances are certified by the manufacturer for application in common vent configurations.

! → (c) The venting system is sized appropriately by the appliance manufacturer or in accordance with its instructions and as such is considered a ***special venting system*** as defined in Clause 3.

(d) The venting components are either supplied or as recommended by the appliance manufacturer.

(e) A method of flue backflow prevention is present in either the appliance or vent for each appliance and is installed in accordance with the appliance manufacturer's instructions.

(f) The manufacturer's operation and installation instructions shall include common venting specific instructions.

(g) The special venting system or unique feature(s) necessary for common venting application shall be in accordance with the applicable ANSI or CSA standards for the specific appliance type, ANSI Z21.13- 2004 and CSA 4.9 being the case for boilers.

The simple fact is that we blame many venting problems on the wrong things.

Mostly because we don't have a proper method to predict potential issues

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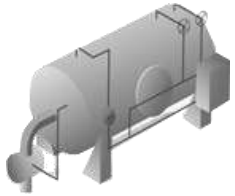
ANSI Appliance Categories:

	- Negative Outlet Pressure	+ Positive Outlet Pressure
Non-Condensing	UL-441 “B-Vent”  Galvanized Liner, SS Liner, Masonry I	UL-103 “Pressure Stack” SS Liner  III
Condensing	UL-1738 “Special Gas Vent”  AL29-4C, Approved SS, Polypropylene II	IV UL-1738 “Special Gas Vent” AL29-4C, Approved SS, Polypropylene 

Common Design Methods:

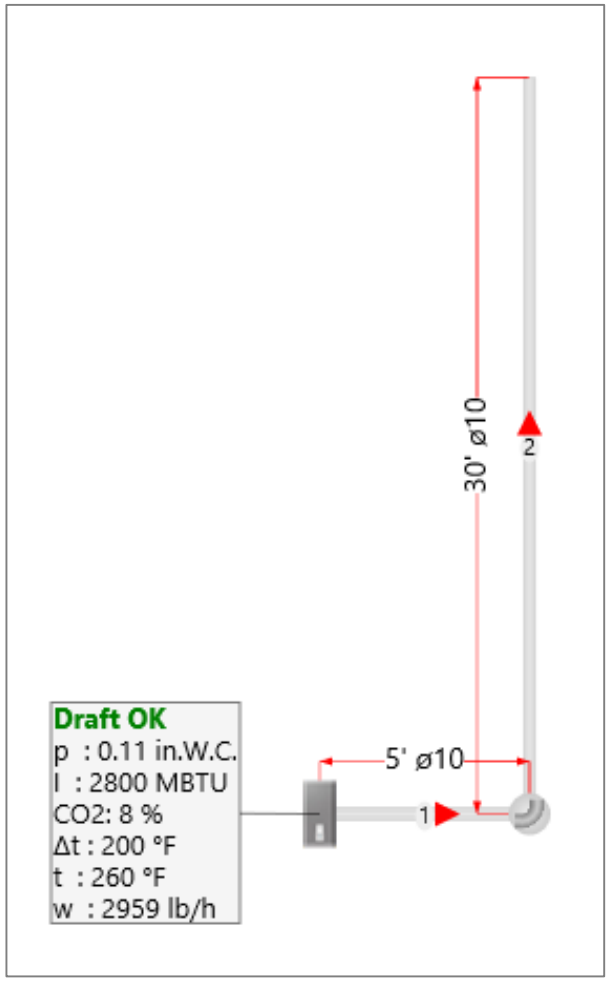
- Equivalent Length Method
- GAMA Vent Tables
- The ASHRAE Chimney Design Equation

Equivalent Length Method:

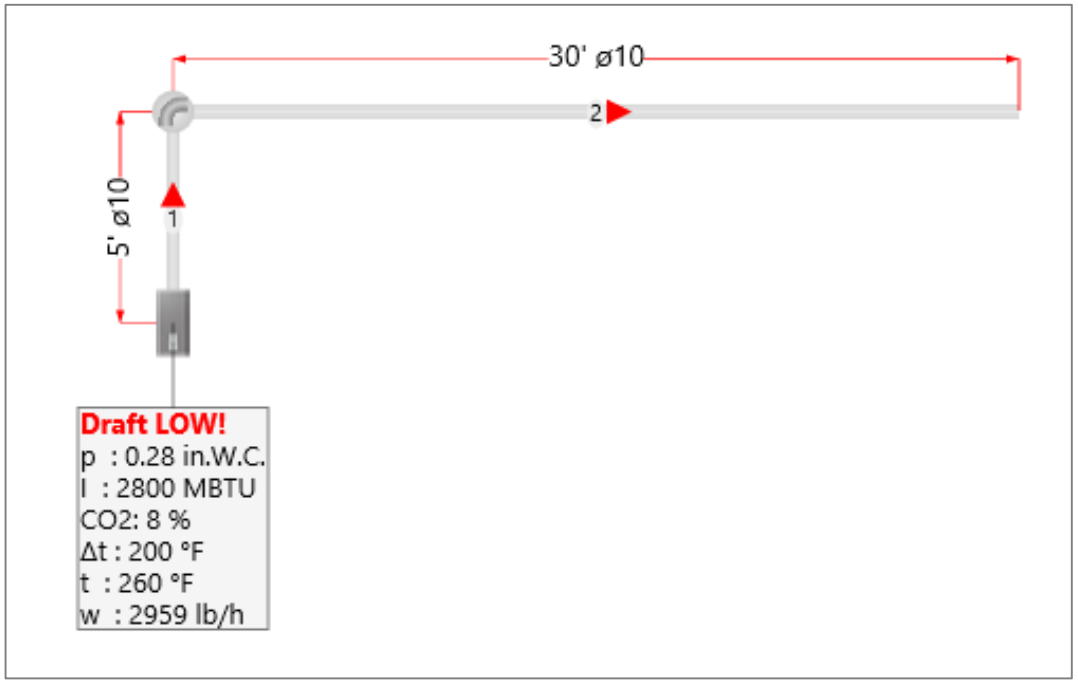
- Based on total length of vent
- Each fitting is defined as a length, typically 10 feet
- Simple and easy to use

- Not accurate
- Not considering natural draft effects
- Cannot be used for common-venting

Equivalent Length Method:



35', single elbow, max. back pressure 0.25 in.W.C.



GAMA Vent Tables:

- Simple and easy to use
- Covers single-appliance and common venting

- Category I (Draft Hood and Fan Assist) Only
- Limited to typical layouts
- No consideration for many types of components
- User must check for other common code violations

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GAMA Vent Tables:

TABLE 1

Height H (ft)	Lateral L (ft)	Vent and Connector Diameter - D (inches)																					
		3"			4"			5"			6"			7"			8"			9"			
		Appliance Input Rating in Thousands of Btu Per Hour																					
		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
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	93	413	273	110	530	354
8	0	0	84	50	0	165	94	0	276	155	0	415	235	0	583	320	0	780	415	0	1006	537
	2	12	57	40	16	109	75	25	178	120	28	263	180	42	365	247	50	483	322	60	619	418
	5	23	53	38	32	103	71	42	171	115	53	255	173	70	356	237	83	473	313	99	607	407
	8	28	49	35	39	98	66	51	164	109	64	247	165	84	347	227	99	463	303	117	596	396
10	0	0	88	53	0	175	100	0	295	166	0	447	255	0	631	345	0	847	450	0	1096	585
	2	12	61	42	17	118	81	23	194	129	26	289	195	40	402	273	48	533	355	57	684	457
	5	23	57	40	32	113	77	41	187	124	52	280	188	68	392	263	81	522	346	95	671	446
	10	30	51	36	41	104	70	54	176	115	67	267	175	88	376	245	104	504	330	122	651	427
15	0	0	94	58	0	191	112	0	327	187	0	502	285	0	716	390	0	970	525	0	1263	682
	2	11	69	48	15	136	93	20	226	150	22	339	225	38	475	316	45	633	414	53	815	544
	5	22	65	45	30	130	87	39	219	142	49	330	217	64	463	300	76	620	403	90	800	529
	10	29	59	41	40	121	82	51	206	135	64	315	208	84	445	288	99	600	386	116	777	507
	15	35	53	37	48	112	76	61	195	128	76	301	198	98	429	275	115	580	373	134	755	491
20	0	0	97	61	0	202	119	0	340	202	0	540	307	0	776	430	0	1057	575	0	1384	752

ASHRAE Chimney Design Equation:

- Greatest amount of accuracy available
- Covers nearly all possible scenarios

- Requires accurate equipment data
- Time consuming, if done by hand
- Steady-state calculation. Special considerations must be made, especially for modern equipment.
- Some flaws require adding methods from ASHRAE Fundamentals

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The Basics:

Starting with the most important:

Your appliance vent data!

Junk in = Junk out

Table 1 Mass Flow Equations for Common Fuels

Fuel	Ratio M of Mass Flow to Input[a]: $M = \frac{\text{lb Total Combustion Products}^b}{\text{1000 Btu Fuel Input}}$
Natural gas	$0.705\left(0.159 + \frac{10.72}{\%CO_2}\right)$
LPG (propane, butane, or mixture)	$0.706\left(0.144 + \frac{12.61}{\%CO_2}\right)$
No. 2 oil (light)	$0.72\left(0.12 + \frac{14.4}{\%CO_2}\right)$
No. 6 oil (heavy)	$0.72\left(0.12 + \frac{15.8}{\%CO_2}\right)$
Bituminous coal (soft)	$0.76\left(0.11 + \frac{18.2}{\%CO_2}\right)$
Type 0 waste or wood	$0.69\left(0.16 + \frac{19.7}{\%CO_2}\right)$

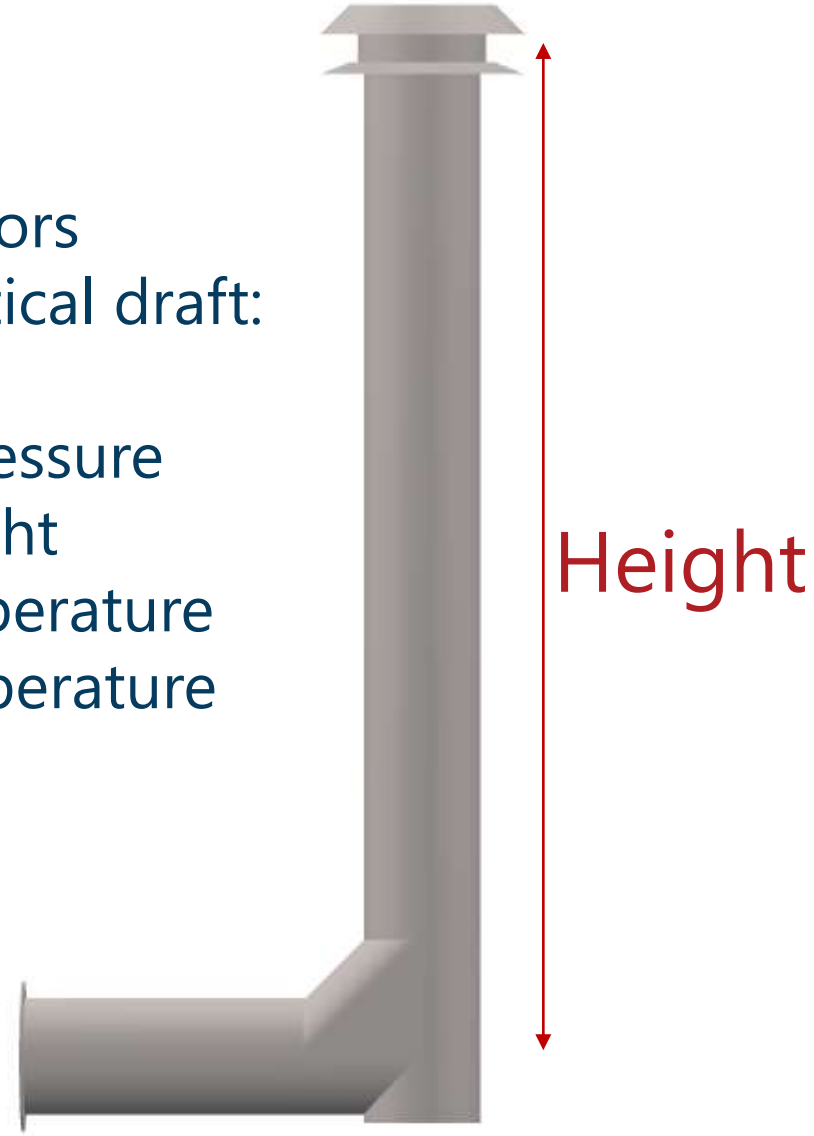
[a]Percent CO_2 is determined in combustion products with water condensed (dry basis).
[b]Total combustion products include combustion products and excess air.

CO2%

The basics:

The primary factors effecting theoretical draft:

- Barometric Pressure
- Chimney Height
- Flue Gas Temperature
- Ambient Temperature



$$D_t = 0.2554BH\left(\frac{1}{T_o} - \frac{1}{T_m}\right)$$

Table 6 Approximate Theoretical Draft of Chimneys

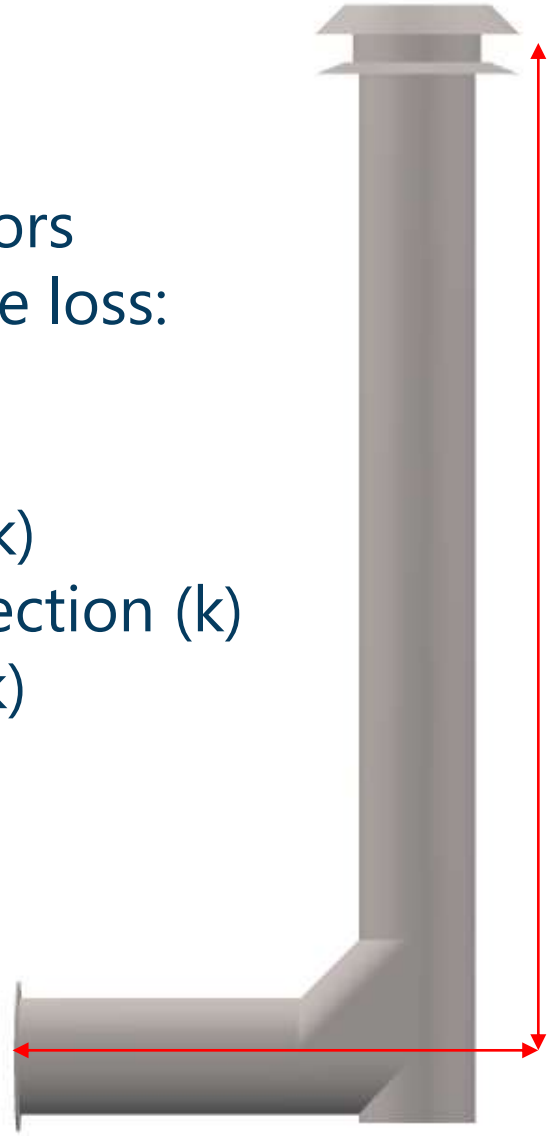
Vent Gas Temperature Rise, °F	D_t per 100 ft, in. of water
100	0.2
150	0.3
200	0.4
300	0.5
400	0.6
500	0.7
600	0.8
800	0.9
1100	1.0
1600	1.1
2400	1.2

Notes: Ambient temperature = 60°F = 520°R
Chimney gas density = air density
Sea-level barometric pressure = 29.92 in. Hg
Equation (9) may be used to calculate exact values for D_t at any altitude.

The basics:

The primary factors effecting pressure loss:

- Mass Flow (w)
- Acceleration (k)
- Change of direction (k)
- Vent Length (k)



$$\rho_m = 1.325\frac{B}{T_m}$$

$$V = \frac{144 \times 4w}{3600\pi\rho_m d_i^2}$$

$$\Delta p = \frac{k\rho_m V^2}{5.2(2g)}$$

Available draft is:

$$D_a = D_t - \Delta p$$

Challenges with modern equipment:

- Generating enough draft with low flue gas temperatures
- Avoiding excessive draft due to high turn-down ratios
- Avoiding back flow thru appliances that are off

Example 1:

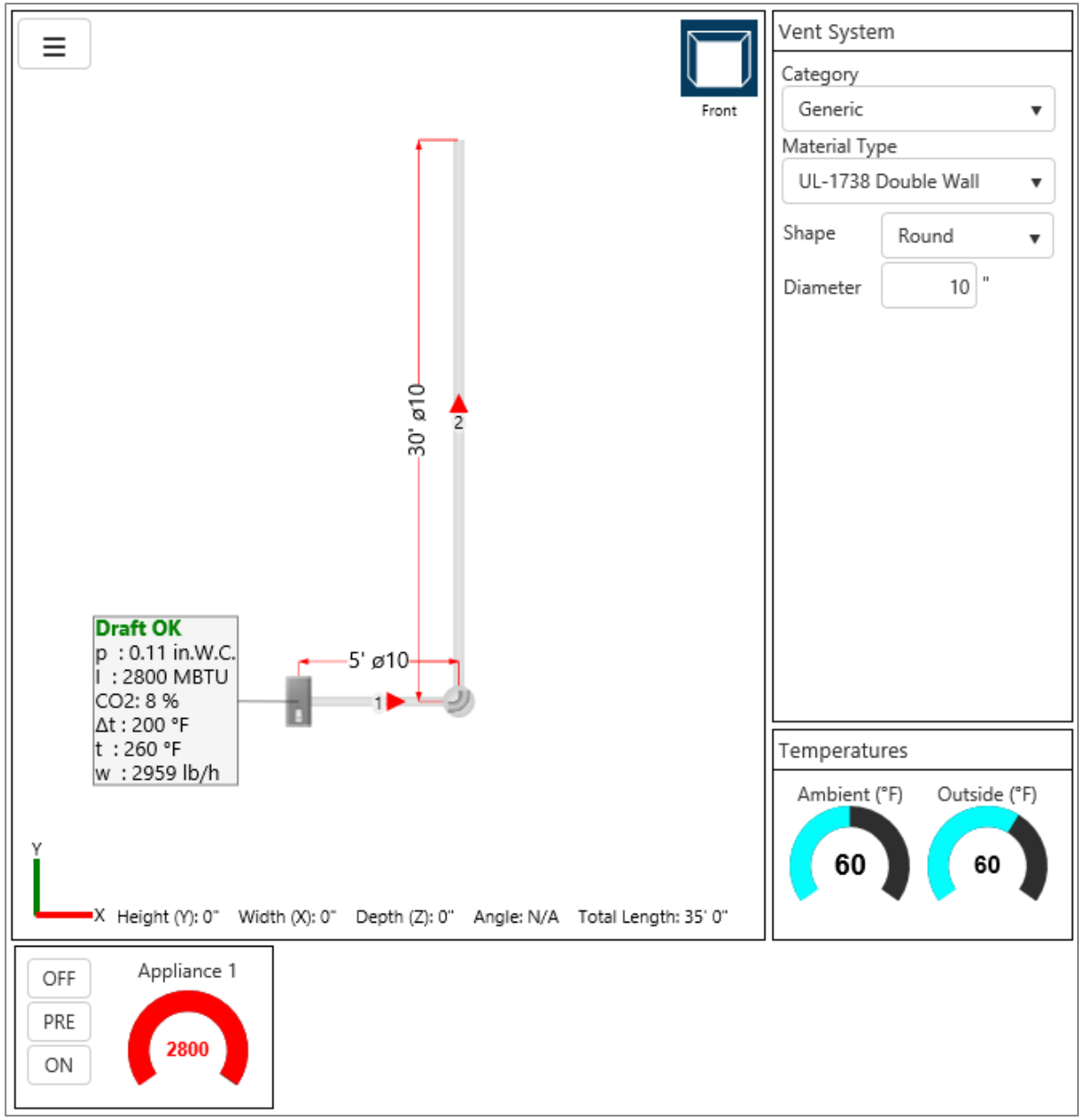
For this example, we have a single Cat IV boiler, 2800 MBH, NG.

Requires-0.1 to +0.25 in.W.C. at outlet.

Steady-state conditions:

Outdoor temp. is 60 ˚F
Appliance is at full load

Outlet pressure: 0.11 in.W.C.



Example 1:

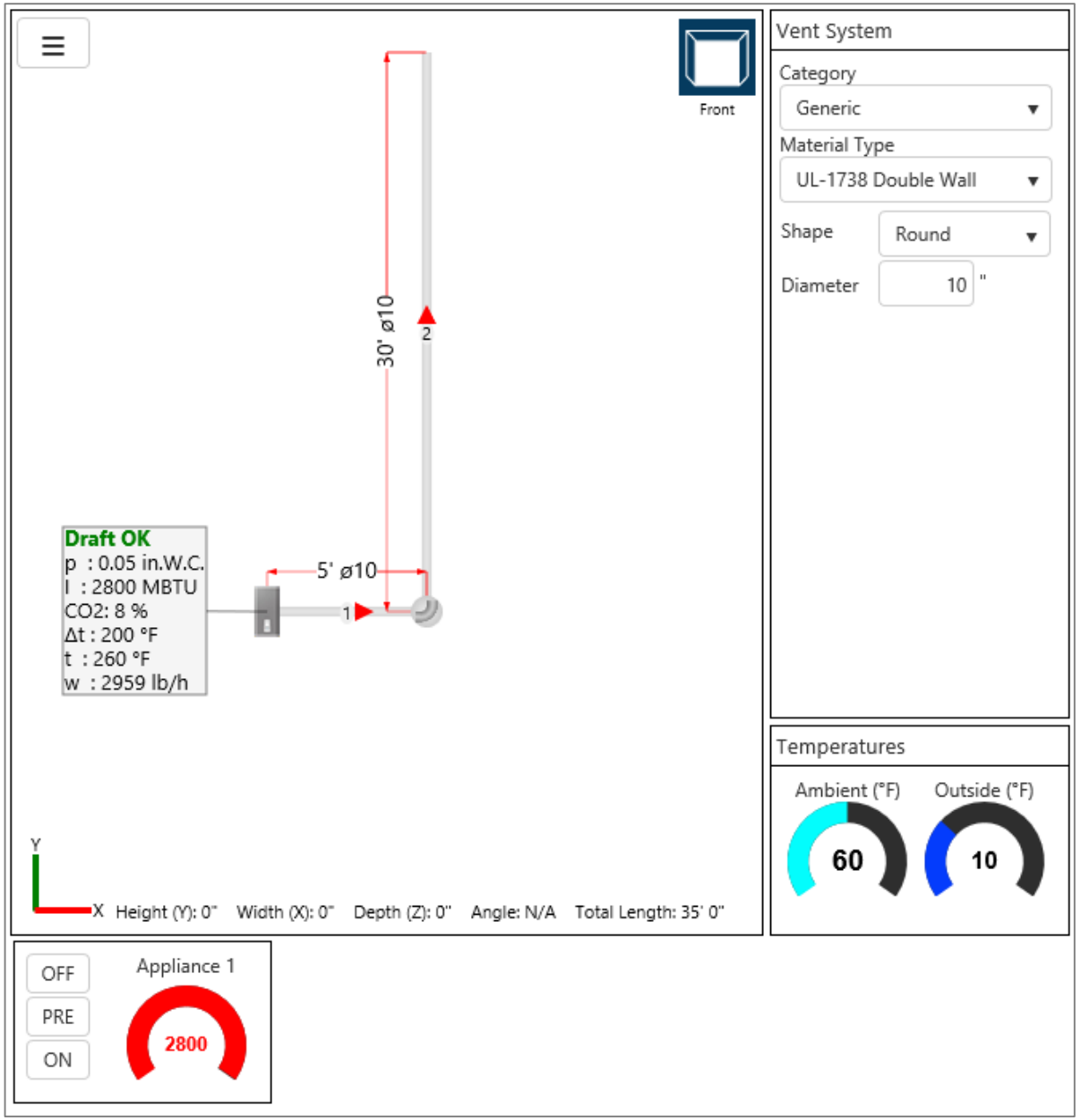
For this example, we have a single Cat IV boiler, 2800 MBH, NG.

Requires-0.1 to +0.25 in.W.C. at outlet.

Variation:

Outdoor temp. is 10 ˚F
Appliance is at full load

Outlet pressure: 0.05 in.W.C.



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Example 1:

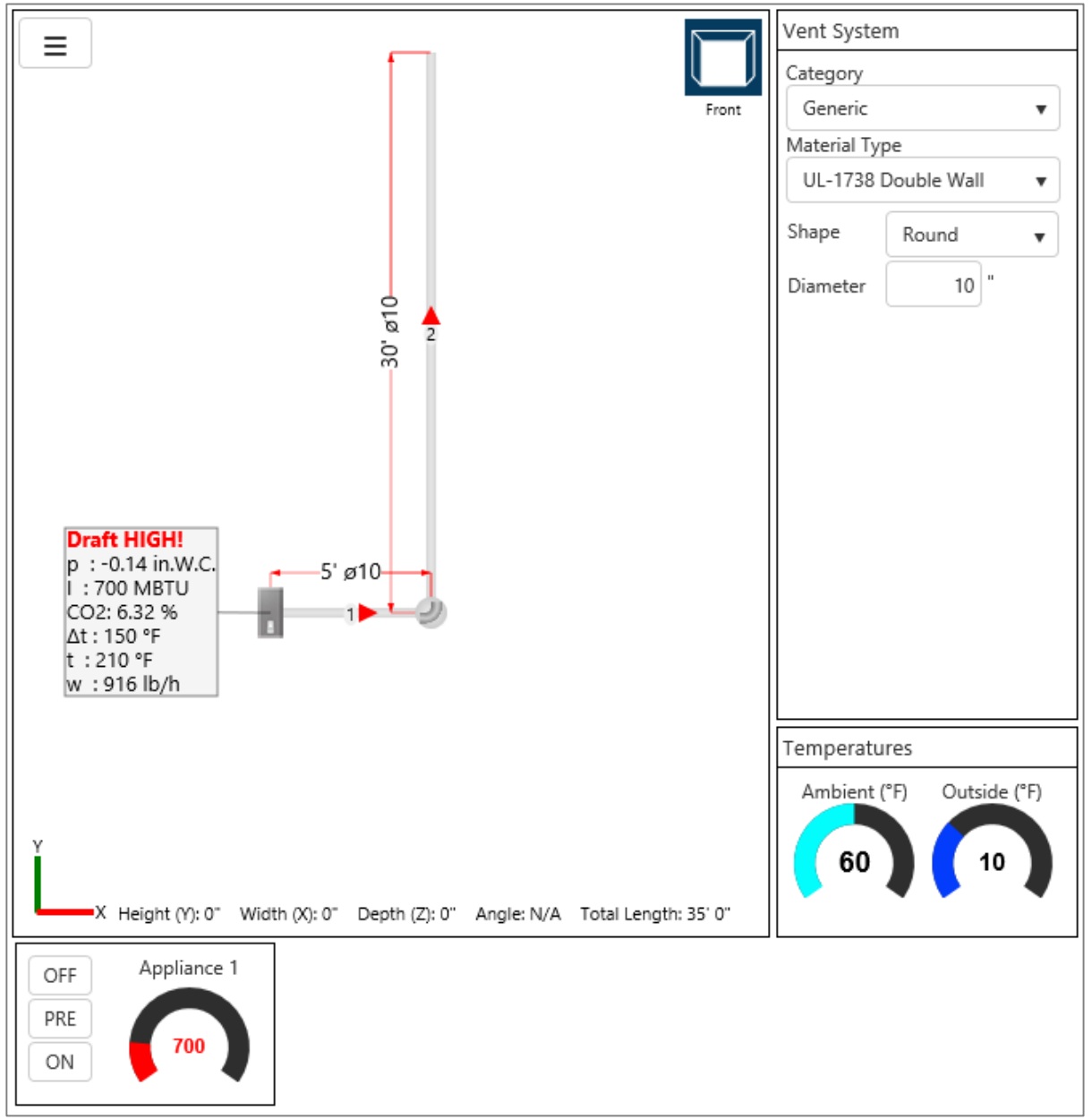
For this example, we assume a single Cat IV boiler, 2800 MBH, NG.

Requires-0.1 to +0.25 in.W.C. at outlet.

Variation:

Outdoor temp. is 10 ˚F
Appliance is at 25% load

Outlet pressure: -0.14 in.W.C.



Example 2:

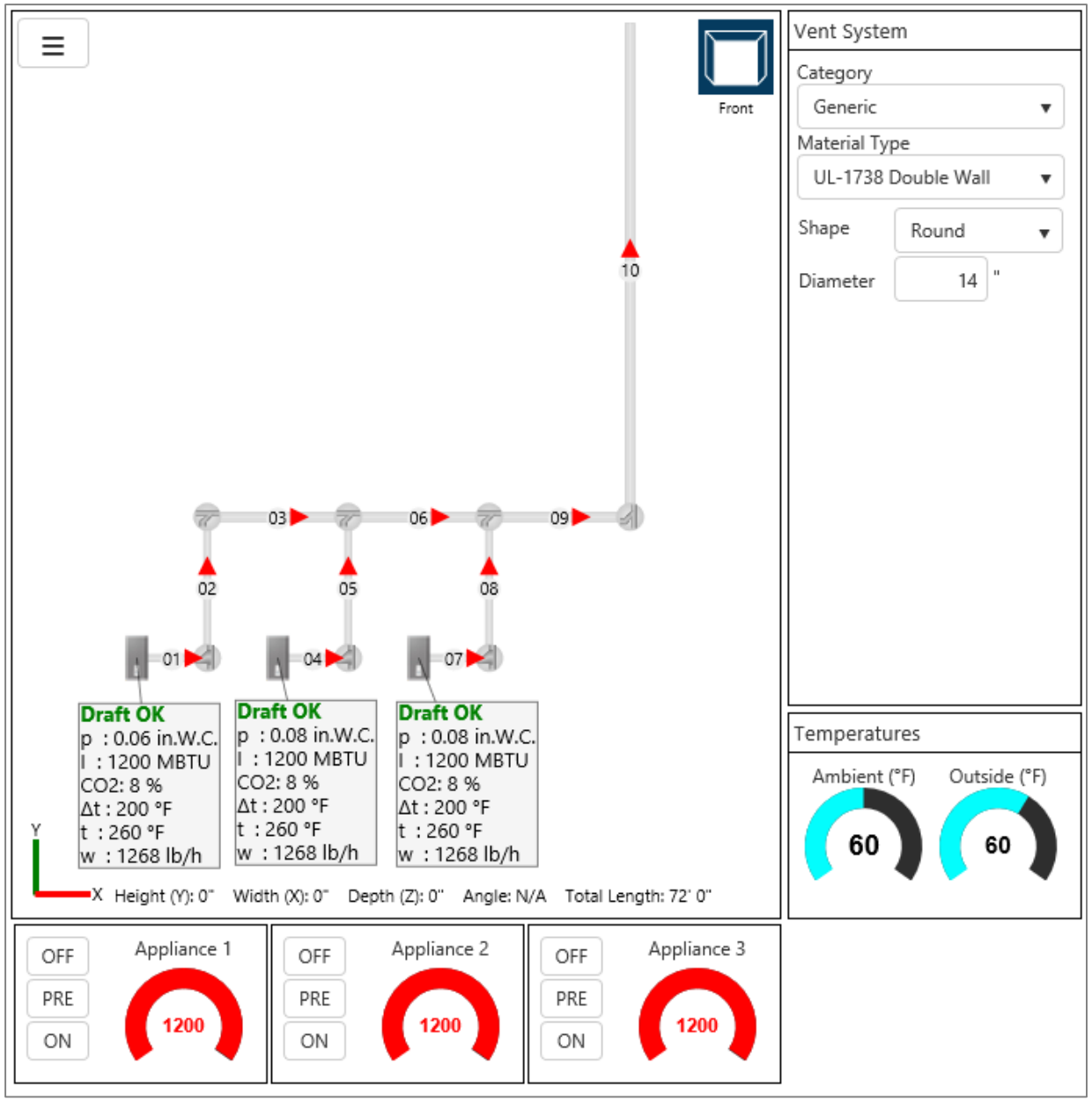
For this example, we have three (3) Cat IV boilers, 1200 MBH each, NG.

Require -0.1 to +0.25 in.W.C. at outlet.

Steady-state conditions:

Outdoor temp. is 60 ˚F
Appliances at full load

Outlet pressures are within limits.



Example 2:

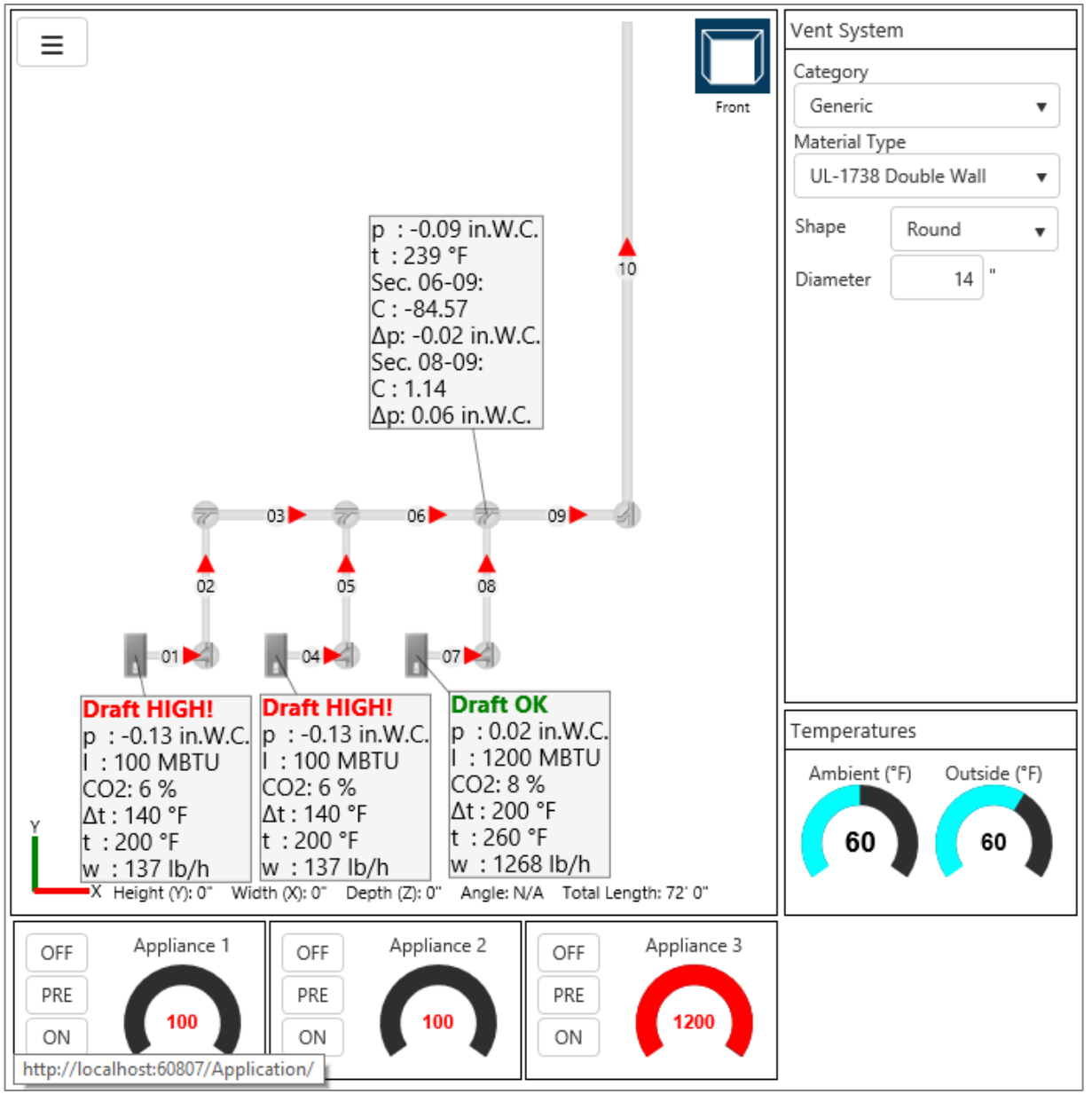
For this example, we have three (3) Cat IV boilers, 1200 MBH each, NG.

Require -0.1 to +0.25 in.W.C. at outlet.

Variation:

Outdoor temp. is 60 ˚F
1&2 @ low fire, 3 @ high fire

Outlet pres. are too negative on 1&2



Example 2:

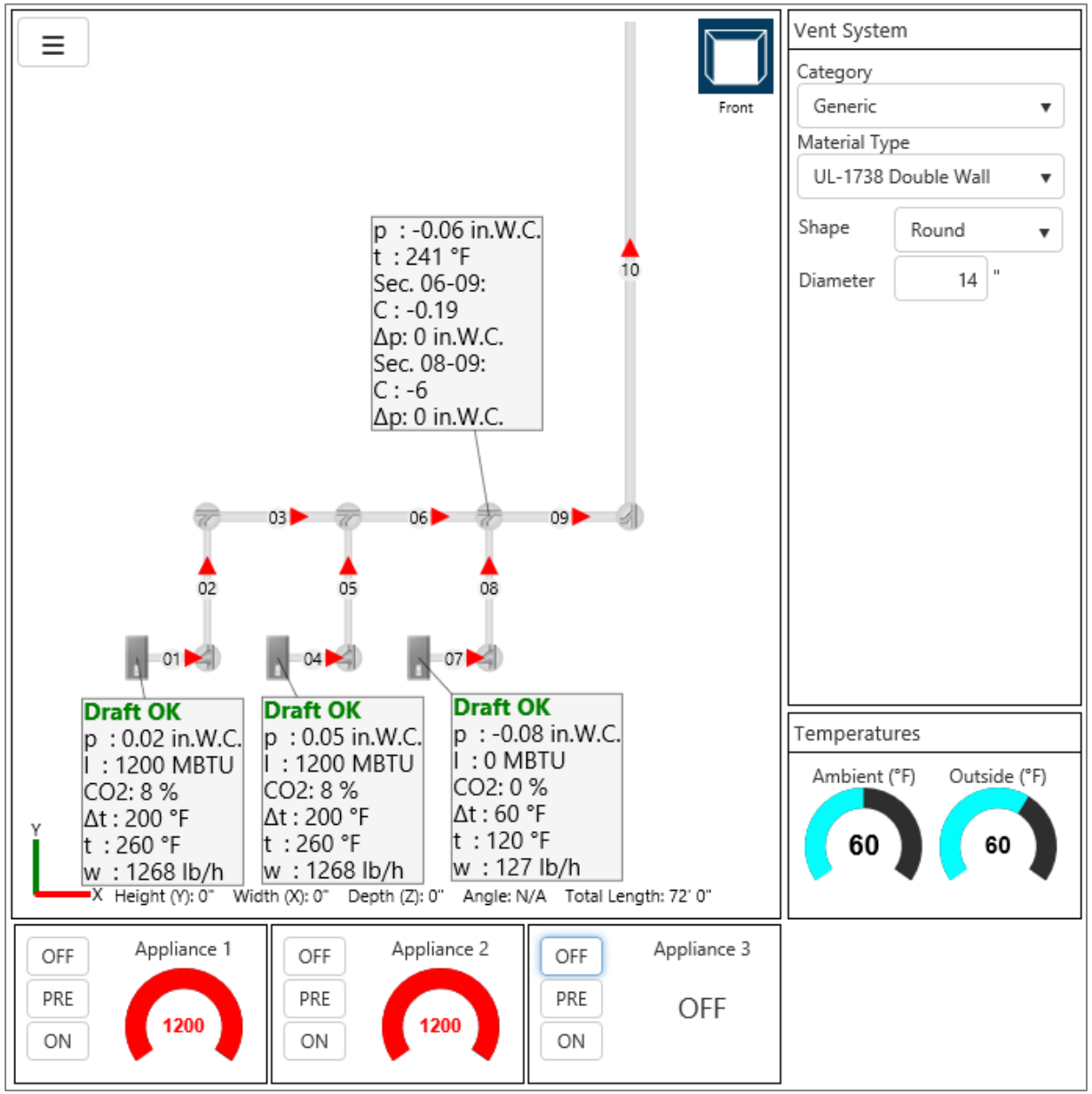
For this example, we have three (3) Cat IV boilers, 1200 MBH each, NG.

Require -0.1 to +0.25 in.W.C. at outlet.

Variation:

Outdoor temp. is 60 ˚F
1&2 @ high fire, 3 is OFF

Outlet pressures are within range, common point in header is negative



Overdraft Prevention:

Barometric Damper

- Works by mixing room air into the flue gasses
- Only for use under negative pressure
- Spill switches or other safety devices should always be used

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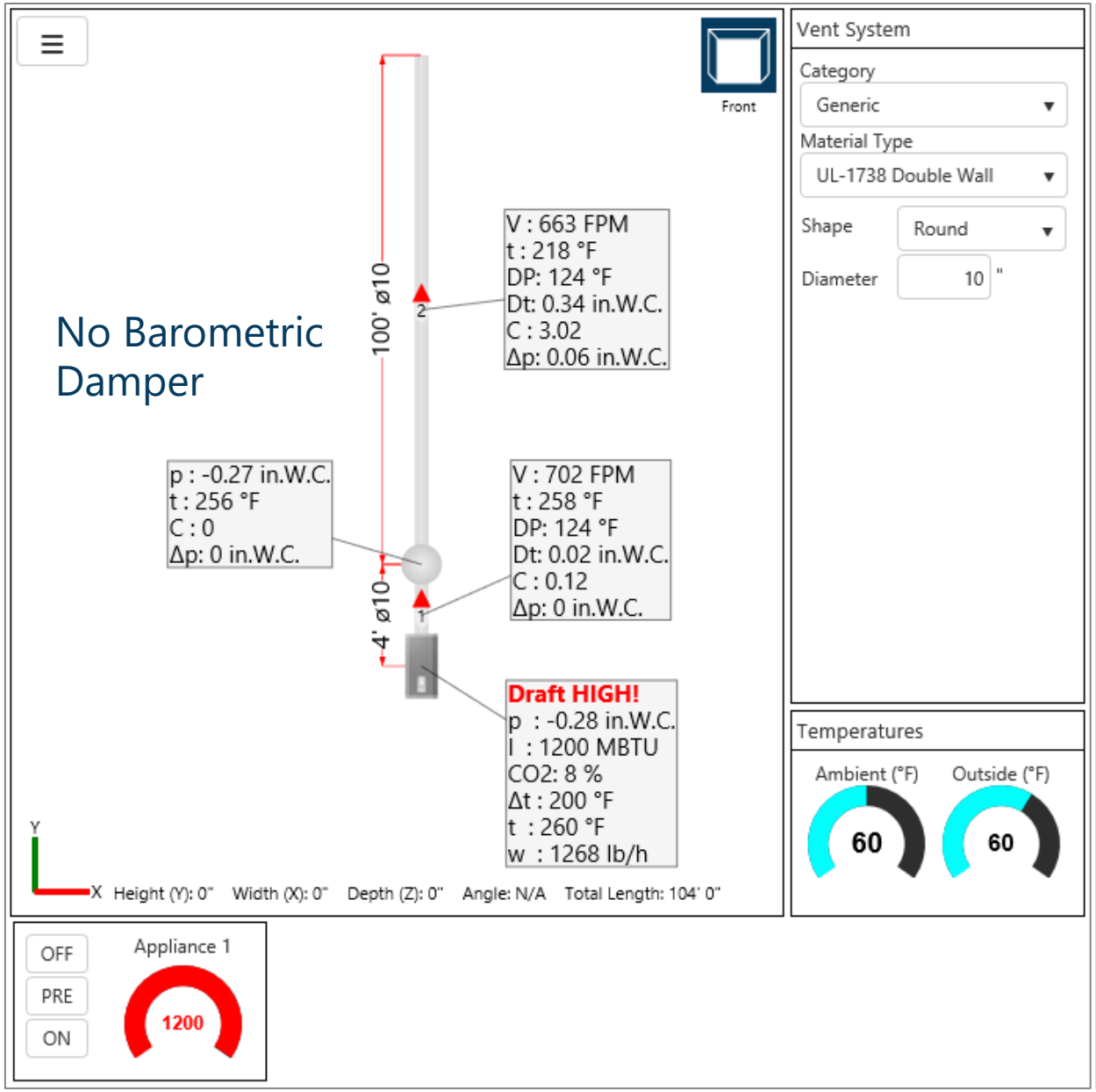

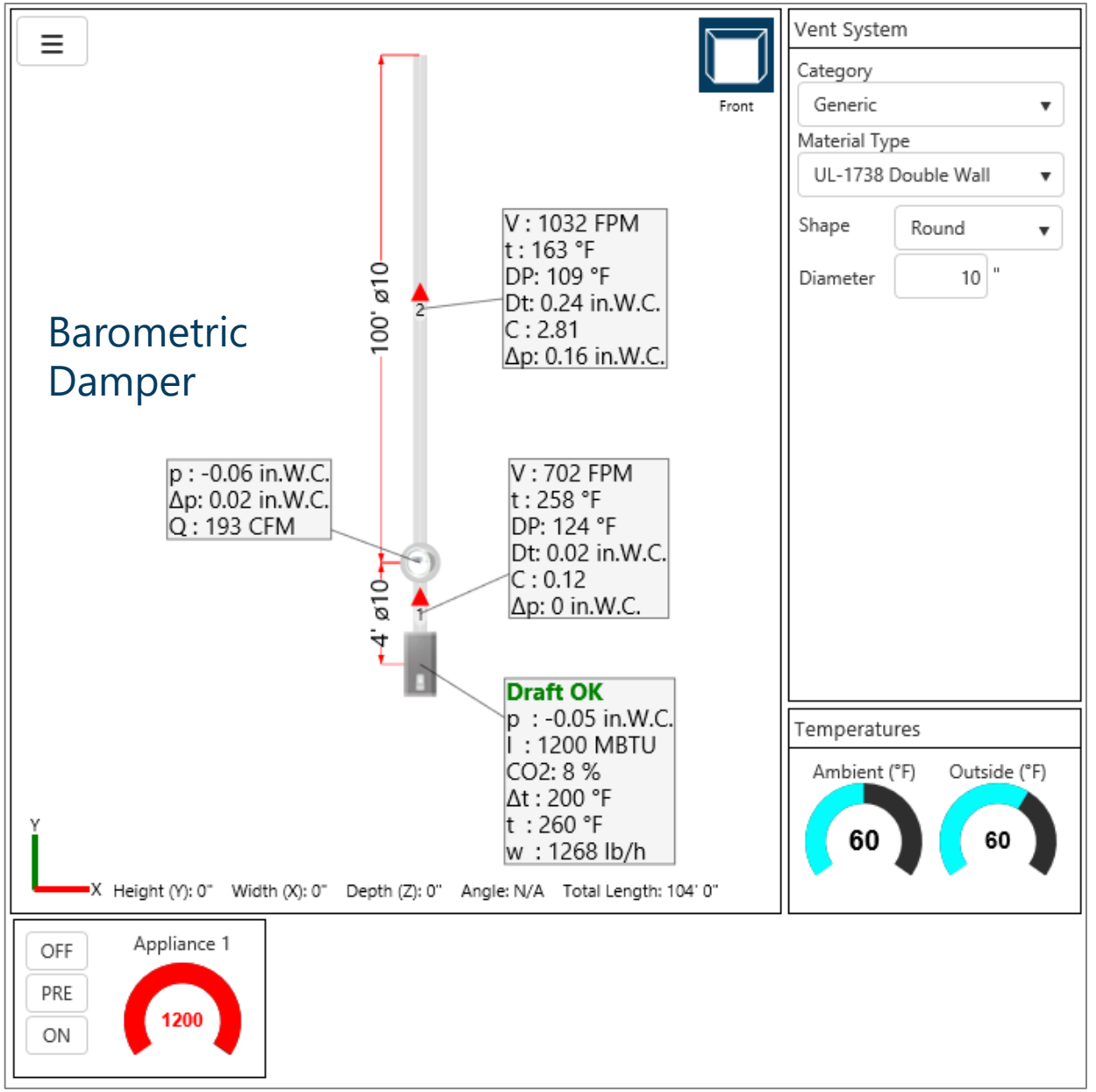

Overdraft Prevention:

Modulating Dampers

- Works by restriction air flow
- For use under both negative and positive pressure
- Spillage not possible

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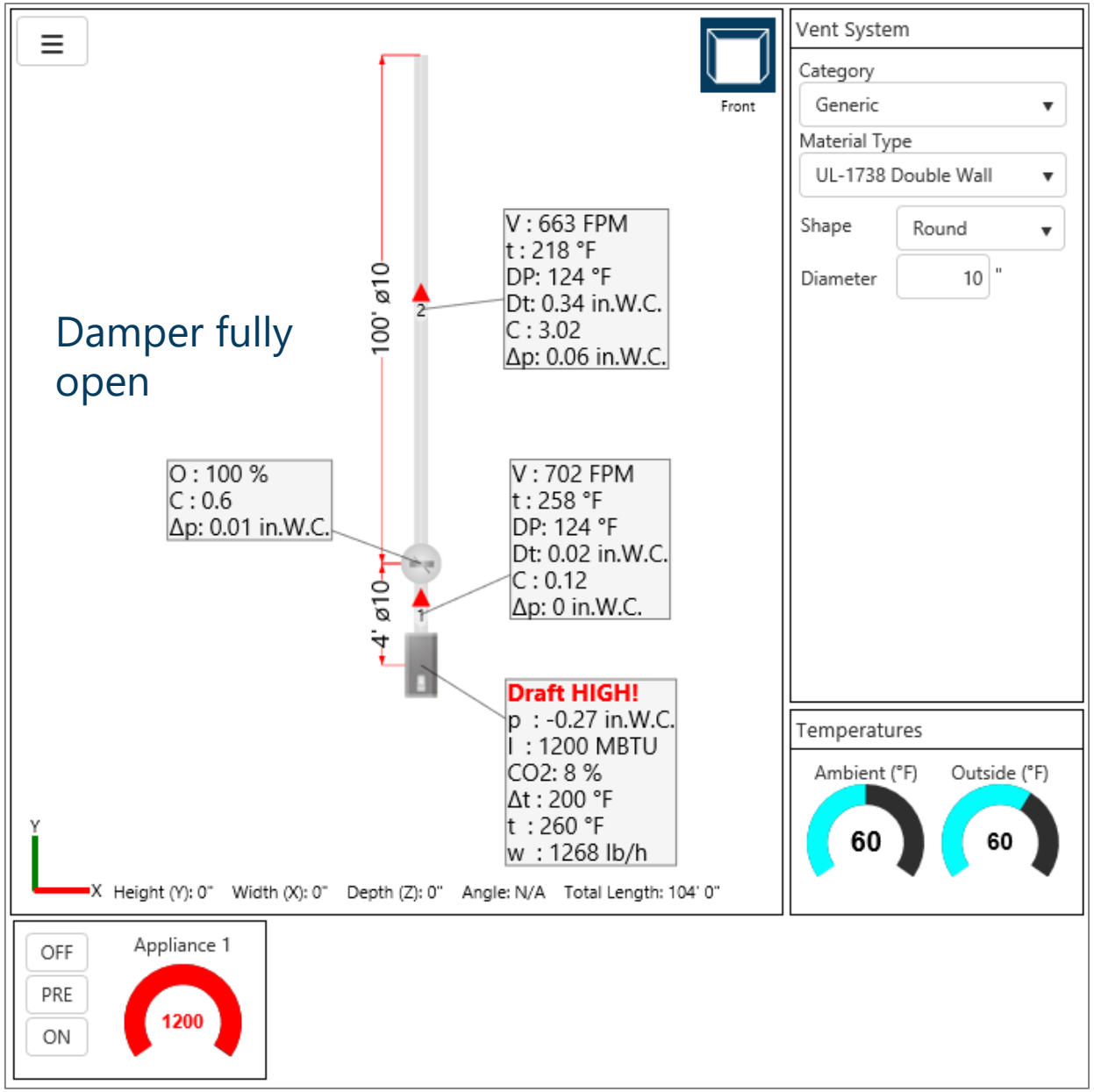
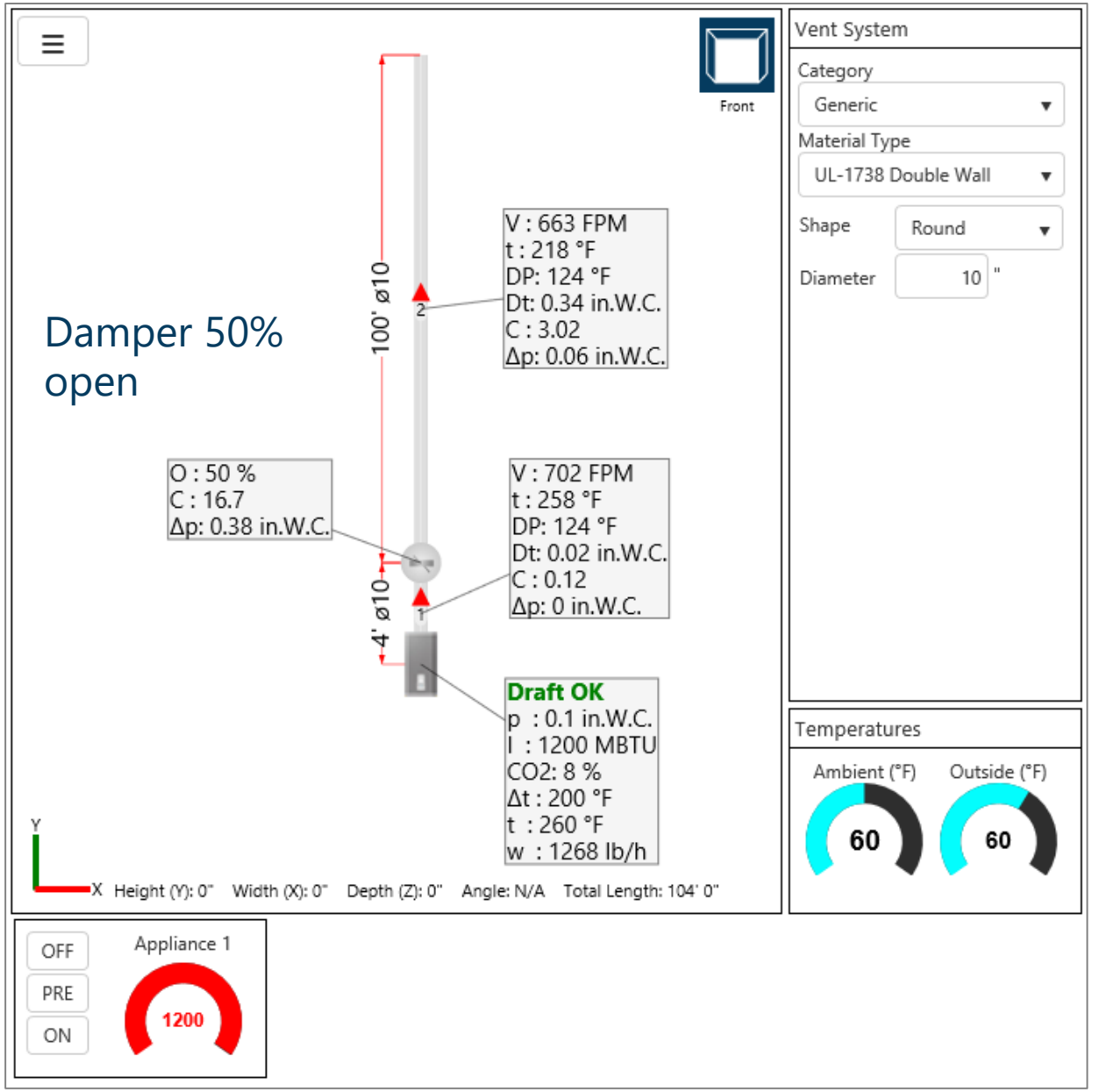
Damper fully open



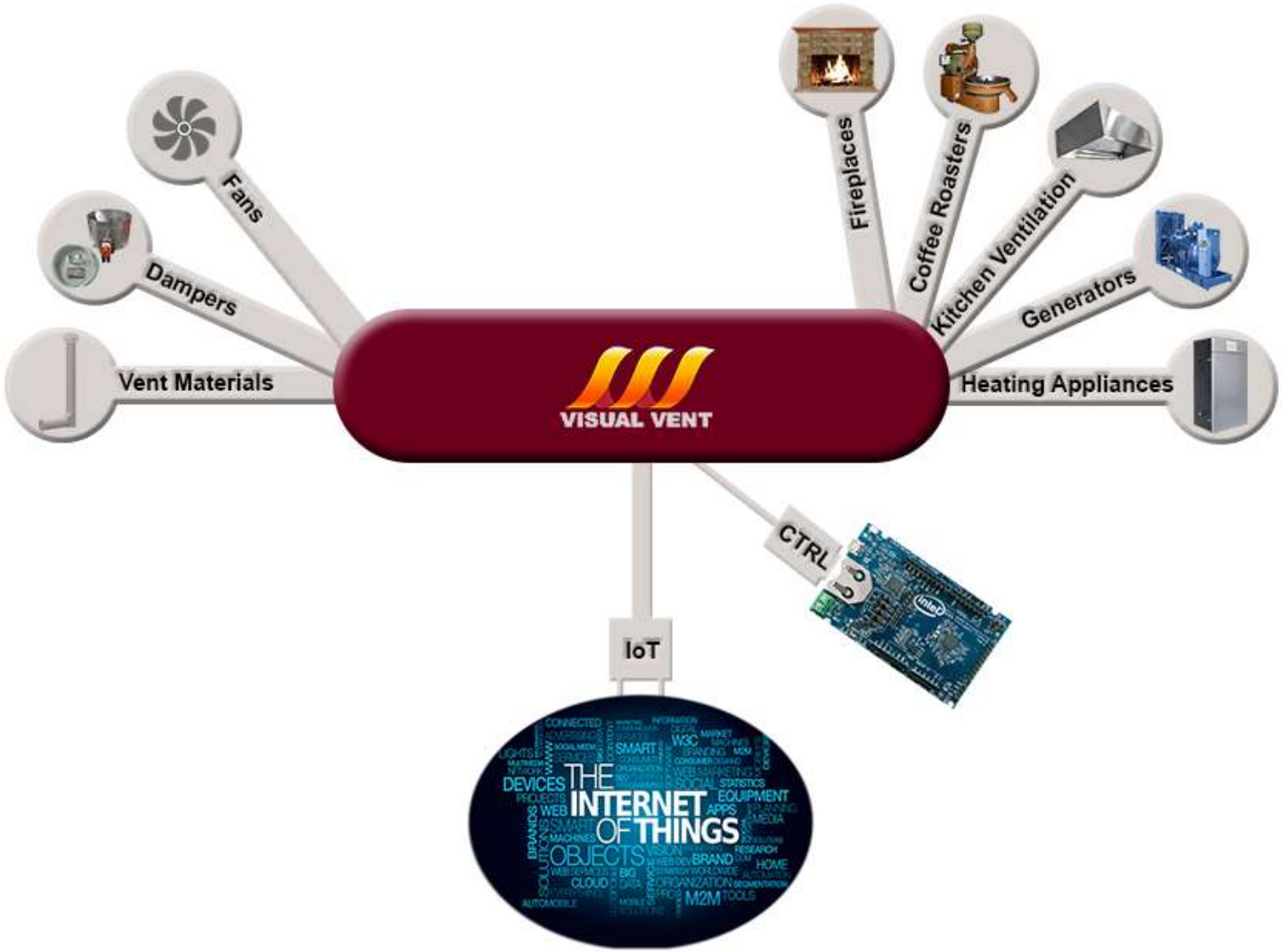
Damper 50% open



Backflow Prevention:

Damper with seal

- Closes when the appliance is off
- For use under both negative and positive pressure
- Spillage not possible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