



Depressurization Issues: Making Sure the Chimney Wins

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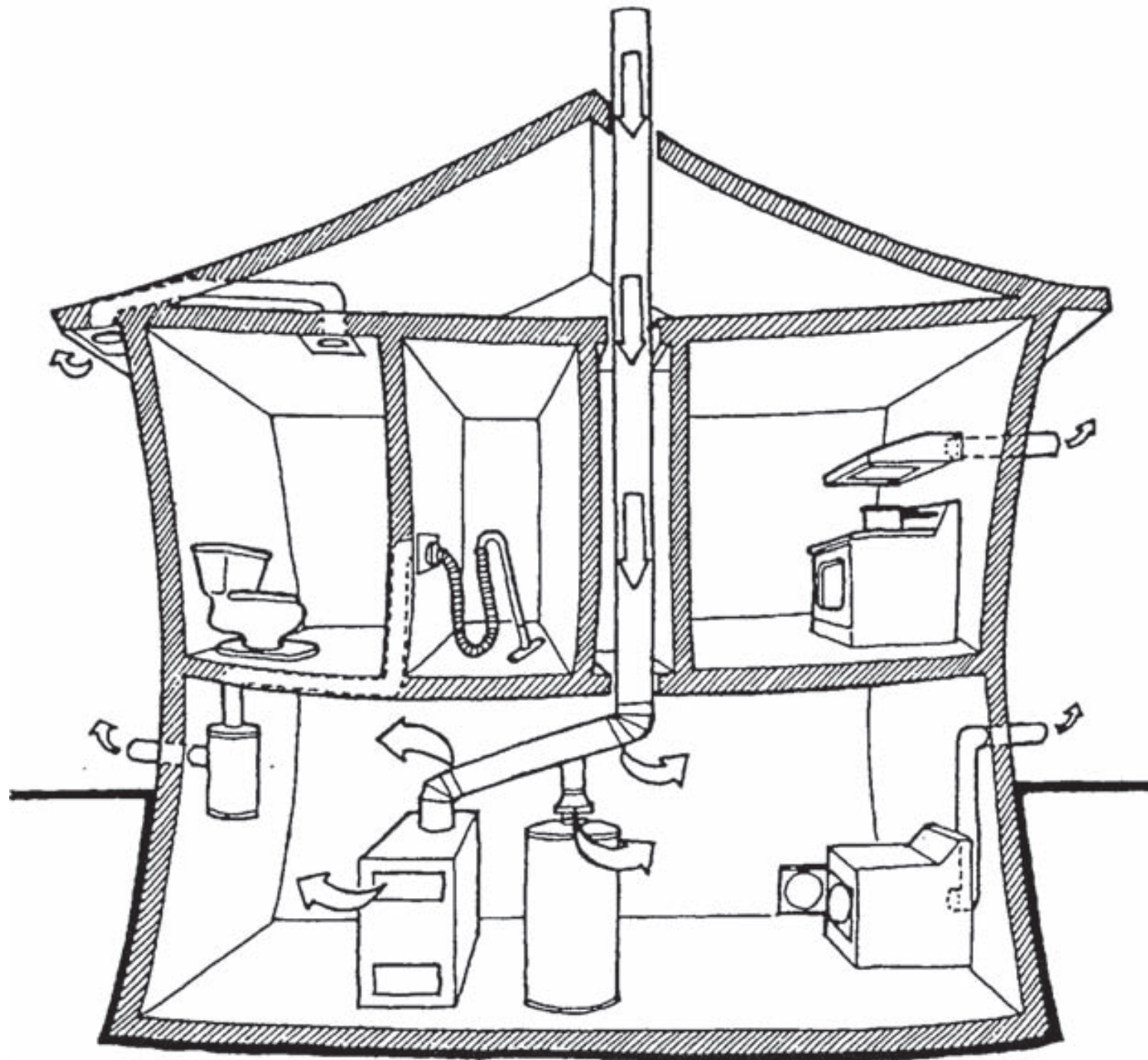
What we will cover in this presentation

- Basic depressurization limit theory
- Existing depressurization limits
- Limits on limits
- Alternatives to depressurization limits
- “Spillage-resistant” appliances
- Minneapolis field testing
- Proposed new limits



What is depressurization?

- House depressurization happens when the air pressure in the house is generally lower than the pressure outside
- If you crack open a window when a house is depressurized, the air will come into the house





What causes depressurization?

- Lots of things – wind, temperature differences, fans, furnaces, open windows, etc.
- One consistent cause is air being exhausted from the house by fans (bathroom fans, range hoods, ventilation systems, dryers, etc.)
- The more exhaust from the house, the higher the depressurization

What is wrong with depressurization?

- Chimney reversal is the big problem: when a cold chimney flows backwards, it is hard for the appliance to establish draft
 - Appliance can spill combustion products into the house for many minutes
 - Air quality hazards associated with combustion spillage
- Other factors: higher radon entry, gases pulled in from attached garages, doors whack you in the nose, etc.

What are depressurization limits?

- They are a way to pre-determine whether a combustion appliance will be at risk of spilling in a home
- There is a depressurization limit assigned to an appliance:
 - E.g. 5 Pa for a gas furnace on a chimney
- Then there is a test to see if the house will produce that level of depressurization



House depressurization testing

- Different test methods specify different fans/appliances to be activated
- Generally stack and wind pressures are not considered
 - Too time or seasonally specific
 - High wind/cold temperatures usually aid chimney draft

Example test

- Depressurization limit of 5 Pa for a gas furnace and water heater
- Dryer, range hood, and (unbalanced) furnace fan activated
- Pressure measured in furnace room is negative 4 Pa
 - House passes

Depressurization limits (Pa)

	CGSB 51.71 (2004)	National Building Code of Canada (2005)	Minnesota Building Code
Gas or oil furnace with chimney	5	5	5
Gas DHW	5	5	2
Power-vented DHW	20	Infinite (but disputed by code officials)	25
Condensing gas furnace	20	Infinite	25

Limits on limits

- Depressurization limits are just an approximation
 - They are usually quite conservative (biased to safety)
- Code infractions will make appliances spill at lower depressurizations
- Is 4.9 Pa a pass and 5.1 Pa a failure?
 - Hard to justify this level of precision
- Limits are hard to apply to woodburning

Limits on limits

- If you cannot say with certainty that 4.9 Pa a pass and 5.1 Pa a failure, what do you say?
- Generally, I advise (for a 5 Pa limit) that 3 Pa and under is a pass; 6 Pa and over is a failure; and 4-5 Pa should be further investigated or marked
- Programs cannot operate with this level of uncertainty



Spillage-resistant appliances

- What are they?
- What limits apply?
- What does the research show?







What are they?

- Basically an appliance that, in theory, should not have trouble with any conceivable house depressurization (e.g. 50 Pa)
- Either they have directly ducted air to and from the appliance and sealed combustion
- Or they have a powerful fan which should overcome any conceivable house depressurization

What are they not?

- **An induced-draft, mid-efficiency gas furnace**
 - Why: these are generally vented by leaky B-vents
 - They are also designed to be pressure neutral
 - They are often co-vented with natural draft water heaters

So, do they work at -50 Pa?

- First we tried field testing 100 appliances in Peterborough, Ontario
- Weatherization crew were already doing blower door tests
- Asked them to test the first 100 “spillage-resistant” appliances that they encountered at -50 Pa
- Smoke pencil testing only

So, do they work at -50 Pa?

- Rough criteria used for evaluation:
 - Can feel or see air leakage from burner or venting system at 50 Pa: high or medium spillage (“high” rarely seen)
 - Can detect spillage only with smoke pencil: slight spillage
 - Cannot detect any spillage with smoke: no spillage
- Not quantitative testing

Do they work at -50 Pa?

	Gas furnace	Gas DHW	Gas fireplace	Oil furnace	Oil DHW
Number tested	61	17	14	8	1
No spillage	15	7	1	0	0
Slight spillage	34	9	7	5	1
Medium or high spillage	12	1	6	3	0



So, do they work at -50 Pa?

- The answer would be a qualified “no”
- They may be “spillage-resistant” in theory but not in practice
- Quantification of how much they spill (and how dangerous that is) would have to wait for lab tests

Laboratory testing of spillage from appliances

- Tried woodstoves first
- Measured room CO₂ as indicator of flue gas spillage
- Research failed to find a means to quantify wood spillage at different pressures









Why did lab testing on wood-fired appliances fail?

- It was too hard to do ...
- Wood burn goes for 5-15 hours, instead of 5-15 minutes
 - Hard to say when it stops
- Hours of burn means that the room had to be air conditioned
 - Air conditioner performance affected room pressures

Lab testing of gas “spillage-resistant” appliances

- Why would gas appliances be more practical?
 - Shorter cycles
 - Measurable flue flows
 - No need for AC
 - Better defined burner on-time
- 2% or less spillage defined as criteria for passing the test
 - Taken from vent leakage allowance in gas standards

Lab testing of gas “spillage-resistant” appliances

- Same sort of room, fan depressurization, CO₂ monitoring, etc.
- All appliances were bought new
- All properly installed to code
- Have tested seventeen appliances in the lab so far:
 - 6 water heaters (power-vented or tankless)
 - 7 furnaces (mostly condensing)
 - 4 fireplaces

Gas appliance lab results

- At -50 Pa, 3/17 had spillage $> 2\%$ criteria
- Two fireplaces, on furnace
- Spillage was up to 10% of combustion products
- So ... generally good results, with these appliances having spillage resistance, with a few outliers that could be caught by inspection or testing



Current status

- Test itself is quick and quite simple
- Hoping to interest manufacturers in doing their own testing
- Canadian Standards Association looking into integrating spillage tests into appliance standards

Best possible result?

- Appliances are tested and rated for depressurization resistance by certifying agencies
 - Test integrated into standards
 - Appliances carry a tag (e.g. good to - 40 Pa)
 - No assumptions needed
- This scenario requires support from manufacturers and industry

Summary

- Figure out if a house is at risk
 - Look for chimneys or big fans
- Know how to do a depressurization test
 - CGSB 51.71 is a good example
- Consider installing spillage-resistant appliances if the house is at risk
 - Emphasize that they are more energy efficient
- Make sure any house with combustion devices has CO alarms