Outside Combustion Air for Masonry Heaters:
A Technical White Paper by Solid Rock Masonry Heaters

Research Review, Risk Analysis, Practical Solutions, and a Call for Updated Testing in Modern Construction

Author:

Eric Moshier - Solid Rock Masonry Heaters

· Certified Masonry Heater Builder, Masonry Heater Association of North America (MHA)

· Member, ASTM Committee E06 - Subcommittee on Solid Fuel Burning Masonry Heaters (ASTM E1602)

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Abstract: This white paper addresses one of the most persistent questions in masonry heater installation practice: does a masonry heater require a dedicated outside combustion air supply in tight, energy-efficient homes? Drawing on formal government-funded aerodynamic research, Canadian building code history, and the published work of recognized authorities on combustion venting, this paper concludes that outside combustion air is not physically required for properly designed overfire-air masonry heaters operating in standard tight construction. Direct-connect outside air ducts, often recommended without qualification in green building literature, introduce their own documented hazards including wind-induced draft reversal and heat exposure of non-rated ducting. Passive makeup air openings, tested by CMHC researchers, provide only marginal pressure relief and do not reliably bring house depressurization below the 5 Pa safety threshold. Practical alternatives are presented. The paper also identifies specific gaps in the existing research record, particularly the absence of data for modern ultra-tight construction including ICF and Passive House builds, and outlines a field testing program to be conducted by the author to close those gaps and produce a fully updated, unassailable evidence base.

1. Introduction and Purpose

As residential construction has become progressively more airtight, driven by energy codes, voluntary certification programs such as LEED, Net Zero, and Passive House, and the widespread adoption of insulating concrete form (ICF) construction, questions about combustion appliances in tight homes have become more frequent and more urgent. For masonry heaters specifically, the question of outside combustion air arises in nearly every project involving a high-performance building envelope.

The concern is legitimate in the abstract. What makes it complicated is that masonry heaters operate on fundamentally different aerodynamic principles than the wood stoves and open fireplaces for which most outside air guidance was written. Applying generic wood-burning appliance rules to masonry heaters, as a number of green building publications now do, leads to recommendations that are not only unnecessary but introduce their own documented hazards.

The primary published research on this specific question dates from 1994. That research is scientifically sound and its core conclusions remain valid because they rest on fundamental fluid dynamics. However, residential construction has changed materially since 1994. This paper presents the existing evidence, explains why it remains applicable, identifies the specific scenarios where additional data is needed, and proposes a path to producing that data through field testing conducted by the author.

2. Why Masonry Heaters Are Not Wood Stoves

The outside air debate has largely been shaped by research on open fireplaces and continuously burning metal stoves. Applying those conclusions to masonry heaters requires understanding the following fundamental differences:

- **Batch firing, not continuous operation.** A masonry heater burns a single charge of wood for 2 to 3 hours, then the fire is out and the damper is closed. The heater radiates stored heat for 12 to 24 hours with no combustion occurring and no air being drawn from the house. A conventional wood stove may burn continuously for 8 to 12 hours or more, drawing house air throughout.
- **Throttled overfire combustion air.** Modern masonry heaters deliver combustion air through a controlled door inlet. In the case of Solid Rock heaters, 80% is delivered as overfire air through the door's air frame and 20% at the door base. This throttled orifice governs total air consumption and prevents the uncontrolled positive-feedback blowtorch effect that Senf[2] documented when outside air is connected directly to the firebox of a conventional fireplace.
- **Thermal mass and tailout immunity.** The masonry body and inside chimney store approximately 50 kWh of heat. This thermal reserve maintains strong chimney draft throughout and well after the burn, documented in one test as unchanged 35 hours after the fire ended.[2] This eliminates the tailout draft reversal risk that is the primary safety concern justifying outside air for low-mass appliances.
- **Low air consumption by design.** Because the combustion air inlet is throttled, overfire-air masonry heaters consume significantly less air than conventional fireplaces. The CMHC study measured peak consumption under 30 L/s, compared with up to 80 L/s for older underfire-grate designs.[2]

3. The Foundational Study: Senf / CMHC (1994)

The definitive scientific study on masonry heater air requirements was conducted by Norbert Senf of Masonry Stove Builders, developer of the HeatKit system, founding member of the MHA, and the most prolific technical researcher in North American masonry heater history. Funded by the Housing Technology Incentives Program of Canada Mortgage and Housing Corporation (CMHC), the report *Air Requirements and Related Parameters for Masonry Heating Systems* (March 3, 1994) remains the only formal aerodynamic study of masonry heater air consumption conducted in North America.[2]

Five contraflow heaters were tested using the CMHC Duct Test Rig across multiple operating conditions. Four had 18-inch fireboxes; one had a 22.5-inch firebox. Results were modeled in the WOODSIM whole-house simulator against a real R-2000 certified house with an Equivalent Leakage Area (ELA) of 0.02 m^2 at 10 Pa, equivalent to the leakage area of a 6-inch diameter hole, noted as the tightest house available at the time. The two 5-inch HRV envelope penetrations in that house were assumed to be sealed for the simulation. When an HRV is turned off, its internal dampers close automatically, providing the same seal as taped penetrations. The modeled condition therefore reflects any period during which the HRV is not running, not only blower door test conditions. The 5 Pascal House Depressurization Limit (HDL) is the widely accepted safety threshold for naturally vented combustion appliances.

3.1 Key Measured Results

Configuration	Peak Air Flow	Depressurization (R-2000 house)	Status
Overfire air - 18" firebox (primary test units)	< 30 L/s	~3 Pa	SAFE
Overfire air - 22.5" firebox (09RUP)	~35 L/s	~3.5 Pa	SAFE
Underfire air - grate designs	Up to 80 L/s	Up to ~8 Pa	Can exceed limit
Heater with outside air - door leakage only	2-6 L/s	< 1 Pa	SAFE

Source: Senf (1994).[2] Depressurization from WOODSIM modeling against R-2000 test house (ELA = 0.02 m^2 at 10 Pa; HRV penetrations sealed, equivalent to HRV off). HDL = 5 Pa. The WOODSIM reference fireplace was a small unit with a 6.5 x 10.5-inch flue (modular 8x12 tile). Larger conventional fireplaces draw more air and can push a tight house past 5 Pa.

3.2 Formal Conclusions of the Study

- Airflow rates of overfire-air heaters were low (< 30 L/s). Underfire-air heaters had higher rates, up to 70 L/s.
- Air leakage rates for masonry heater doors tested ranged from 2 to 6 L/s at 25 Pa.
- Masonry heaters are not susceptible to spillage during tailout, as are some other woodburning appliances.
- Masonry heaters with overfire combustion air are suitable for operation in modern, airtight houses, with or without outside air supplies.[2]

> *"We have conducted testing on masonry heater air consumption rates, and shown that outside air is not required, even in a tight house."*
> - Norbert Senf, HeatKit Planning Guide, Foundation Plans section[3]

> *"Your local code may require it. It serves no useful function, otherwise. This may seem like a radical assertion, however it is based on best available science."*
> - Norbert Senf, HeatKit FAQ - Outside Combustion Air[4]

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4. Why the 1994 Research Remains Scientifically Valid and Where Its Limits Lie

This is the most important section for practitioners and code officials who may question data that is now more than 30 years old. The answer requires distinguishing between what has not changed and what has.

4.1 What Has Not Changed: The Underlying Physics

The core calculation in Senf's study is the orifice flow equation: Q = Cd x A x sqrt(2dP / rho), which is fundamental Newtonian fluid dynamics. It has the same answer in 2026 that it had in 1994. Given a fixed door inlet area and a known chimney draft pressure, the airflow through the inlet is determined by physics, not by the year the test was conducted.

The throttling behavior of the combustion air orifice, Senf's key finding on why overfire-air masonry heaters consume less air than expected, is an aerodynamic characteristic of the door design. It does not change as houses become tighter. A tighter house changes how much the heater's air draw affects house pressure; it does not change how much air the heater draws.

The WOODSIM modeling results are also durable. The simulation showed 3 Pa of depressurization at 30 L/s in a tight R-2000 house. That relationship between air consumption, house leakage area, and resulting pressure differential is governed by conservation of mass. It holds regardless of the decade.

4.2 What Has Changed: Construction Standards

Where the 1994 study has genuine limits is in its test house specification. The R-2000 house used had an ELA of 0.02 m^2 at 10 Pa, the tightest house available at the time, but not representative of the tightest modern construction. An important modeling note: the two 5-inch HRV penetrations in the test house were sealed for the simulation, equivalent to the HRV being turned off, since modern HRVs close internal dampers automatically when off. The modeled condition represents any normal HRV-off operating period. The following scenarios were not present in meaningful numbers in 1994 and are now common project types:

- **Passive House certified construction.** Passive House requires 0.6 ACH50 or below, dramatically tighter than the R-2000 test house. At these leakage levels, the relationship between heater air draw and house depressurization is steeper, and cumulative exhaust loads become a more significant factor.
- **Insulating Concrete Form (ICF) construction.** ICF homes routinely achieve 1.0 to 2.0 ACH50 as a baseline, with well-built examples reaching Passive House levels. The monolithic concrete envelope eliminates virtually all incidental infiltration that a framed house relies on as a pressure relief buffer.

- **Net Zero and LEED Platinum homes.** Current Net Zero certification typically requires 1.5 ACH50 or below. These homes also typically carry higher exhaust loads, including larger range hoods, continuous ventilation via ERV/HRV, and multiple bath fans, that combine with heater air draw to create a cumulative pressure scenario the 1994 study did not model.

4.3 The Honest Assessment

For standard tight construction, homes in the 2.0 to 5.0 ACH50 range that represent the large majority of current Energy Star, high-performance, and well-built conventional homes, the 1994 data is fully applicable and the conclusion is clear: outside combustion air is not required.

For genuinely ultra-tight construction below 1.5 ACH50, Passive House, ICF, and equivalent builds, the 1994 study was not designed to answer the question definitively. The physics suggest the heater will still stay under the 5 Pa limit, but a conservative practitioner is right to want current data. Section 11 of this paper proposes exactly that.

Summary for building officials: The 1994 CMHC study is not outdated; its physics are permanent. What it does not address is Passive House and ICF construction, which were rare in 1994. For standard tight homes, the study is definitive. For ultra-tight construction, the author is conducting updated field testing to fill that specific gap. Until that data is published, the practical solutions in Section 9 of this paper address the concern without the hazards of a direct-connect outside air duct.

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5. Canadian National Building Code History: The Requirement Was Removed

The regulatory history of outside combustion air is directly relevant because it demonstrates that a national building code, after reviewing the CMHC research, concluded that the requirement was not supported by the evidence and removed it. This history is documented in Senf's Outside Air Seminar and confirmed by John Gulland of The Wood Heat Organization, a recognized authority on combustion venting in tight construction.[5]

- **1990 NBC.** Required mandatory outside air for all fireplaces: a 100 mm (approximately 4-inch) duct vented directly to the firebox.
- **1993 - Research tabled to the Standing Committee on Part 9.** The CMHC research findings were formally presented. The proposed revision stated: 'Combustion air supplies as currently prescribed are generally ineffective. The requirement to provide combustion air is being deleted from CAN/CSA A-405 and from the Code.'[5]
- **1995 NBC - Requirement removed.** Outside air made non-mandatory. Where voluntarily provided, installation must comply with CAN/CSA A-405 requirements for safe installation, specifically to address the wind-induced reverse flow hazard detailed in Section 6 of this paper.
- **Current NBC.** Requires only a carbon monoxide detector for wood-burning equipment. No outside air supply mandated. Outside air has also been removed from CSA B-365, the installation code for solid fuel burning equipment and appliances.

> *"Air flows to a zone of lower pressure through any available opening, regardless of our wishful thinking. Outside air supplies do not reduce spillage susceptibility; they only affect spillage volume. Managing the indoor pressure environment is the only viable option for preventing combustion spillage from chimney-vented appliances."*
> - John Gulland, The Wood Heat Organization, in Senf Outside Air Seminar, 2000[5]

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6. The Wind Pressure Hazard: Why Direct-Connect Outside Air Can Create the Problem It Claims to Solve

Green building publications that recommend a sealed duct connected directly to the firebox as the solution to depressurization typically omit a hazard that both Senf[2] and Gulland[5] address explicitly: the wind-induced draft reversal.

6.1 The Aerodynamics of Wind Loading on Buildings

When wind strikes a building, Bernoulli's principle creates positive pressure on the single windward face and negative pressure on the three leeward faces. This is not a storm condition or an edge case; it is the normal aerodynamic state of any building in any wind. The practical consequence is that an outside air intake on any given wall has less than an even statistical chance of experiencing positive pressure at any moment when wind is present.

Senf's research documented negative wind pressures on leeward walls up to 50 Pascals.[2] Gulland's analysis of wind loading data extends the upper range to 100 Pa in high wind conditions.[5] Typical masonry heater chimney draft at the firebox inlet during a burn ranges from 5 to 20 Pa. Wind loading sufficient to exceed chimney draft and reverse flow direction in a direct-connect supply duct is therefore a routine weather condition, not an exceptional one.

> *"Up to 50 Pa negative wind pressure is not unheard of, enough pressure to overcome the chimney draft. No building code presently addresses this issue."*
>
> - Norbert Senf, Air Requirements and Related Parameters for Masonry Heating Systems, CMHC, 1994[2]

6.2 Draft Reversal: The Direct-Connect Hazard

When wind-induced negative pressure at the air intake exceeds chimney draft, the supply duct reverses. Instead of bringing cold outside air in, the duct begins carrying hot combustion gases, potentially laden with carbon monoxide, outward through ducting that was never designed for heat exposure. This is not theoretical. It has been documented with photographic evidence, and Senf's research notes several well-documented cases of complete draft reversals in factory fireplaces equipped with direct-connect outside air supplies.[2]

A standard 6-inch insulated aluminum flex duct carrying combustion gases at elevated temperatures, typically routed through or adjacent to wood framing, is a fire hazard. It is also a CO pathway: gases exiting through the duct at a low point on the building exterior can re-enter through windows, doors, or other openings. Outside air inlets located on the leeward side of a building can experience negative pressure up to 100 Pa in high wind, easily sufficient to reverse flow through any duct connected to the firebox.[5]

6.3 Findings of the 1989 CMHC Fireplace Study

The CMHC fireplace air requirements study[6] tested five fireplaces with and without direct-connect outside air. Its conclusions are unambiguous:

- Fresh air intakes supplied less than 25% of required air in some fireplaces, proving the supply is unreliable.
- Air intakes directly connected to fireboxes can experience reverse flow of hot gases. These ducts should be isolated from combustible materials.
- Direct-connected air intakes are not recommended unless the fire chamber is relatively tight and isolated from the house when the doors are closed.
- All fireplaces tested spilled during tailout when house depressurization reached approximately 10 Pa, with or without outside air present. The fireplaces ranged from loose to extremely tight construction; the difference in tightness made no difference in spillage susceptibility. All five were fine at 5 Pa and all spilled at 10 Pa.[6]
- Even with outside air piped directly to the combustion chamber, spillage still occurred at diedown as combustion gases exited around the door seals. A direct-connect supply does not decouple the appliance from house pressure unless the entire appliance is thoroughly sealed.[6]

Central finding from both studies: Outside air supplies do not reduce spillage susceptibility for any appliance type tested. They only affect spillage volume if the threshold pressure is exceeded. For a masonry heater, which formal testing shows stays well under the depressurization threshold with room air alone, a direct-connect duct adds documented hazard while addressing a problem that does not exist in practice for standard tight construction.

6.4 Why Passive Makeup Air Openings Do Not Solve the Problem

A 2003 CMHC technical paper by J.C. Hutton provides specific tested data on the effectiveness of passive makeup air openings, the most common field solution applied when building officials or installers are concerned about depressurization.[13] The findings are direct:

- In a typical house with large exhaust fans, measured house depressurization was 8 Pa with no makeup air inlet. With a standard code-complying passive makeup air inlet fully open, depressurization measured 6 to 7 Pa. The opening made only a marginal difference and did not bring the house below the 5 Pa safety threshold.
- For most houses, even R-2000 houses, the area of a passive intake duct is very small relative to total house envelope leakage area. The pressure relief provided is minimal.
- Passive makeup air inlets can reverse under certain wind conditions, exhausting air to the exterior and further depressurizing the space around the appliance. This has been observed frequently in field surveys.
- Where the inlet duct leads directly to the fire chamber, hot gases exiting through the duct can cause dangerous temperatures on nearby combustible surfaces.

Hutton concludes: the standards for combustion appliances and their installation need to be revised to address depressurization directly, not makeup air. Providing a passive opening does not solve the pressure problem and can introduce additional hazards.[13]

Norbert Senf's technical analysis adds an important distinction between spillage *rate* and spillage *susceptibility*. Tighter appliance doors reduce the volume of spillage that occurs once the depressurization threshold is exceeded, but they do not change the pressure level at which spillage begins. Outside air supplied to a firebox does not lower firebox pressure relative to the room; that is the function of the chimney draft. Spillage susceptibility is determined by house depressurization relative to chimney draft, not by the presence or absence of an outside air supply.[5]

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7. Solid Rock Heater Air Flow Data and Validation Against Senf's Test Units

One of the strongest arguments for the applicability of the 1994 CMHC research to Solid Rock heaters is that the inlet geometry of the Solid Rock door system directly matches the heaters Senf tested. This reflects that the contraflow heater design and its combustion air requirements have remained consistent across North American manufacturers. The data below makes that connection explicit and demonstrates that all three Solid Rock heater sizes stay safely under the 5 Pa House Depressurization Limit in standard tight construction.

Note on methodology: The SR airflow values presented below are calculated using the orifice flow equation Senf applied (Q = Cd x A x sqrt(2dP / rho), Cd = 0.61, rho = 1.2 kg/m^3), applied to the measured door inlet areas for each model. These are calculated values, not yet directly instrument-measured. The field testing program in Section 11 will produce directly measured airflow values for comparison. The agreement between the orifice equation and Senf's directly measured results for 18-inch and 22.5-inch heaters validates the calculation methodology.

7.1 Validation: Solid Rock Sizes vs. Senf's Test Heaters

Four of Senf's five test heaters had 18-inch wide fireboxes. His measured peak air consumption for those overfire-air units was under 30 L/s. The fifth had a 22.5-inch firebox and measured approximately 35 L/s. The table below shows how Solid Rock's door inlet areas map directly to those test units, confirming the 1994 measurements are directly applicable to this product line.

Reference	Firebox / Inlet Size	Senf Measured Peak Flow	SR Calculated Peak Flow (10 Pa)	Agreement
Senf primary group (01TEM, 02SEN, 04SEN, 05MSB, 08AND)	18" firebox, ~18 in^2 inlet	< 30 L/s (overfire)	SR-18: 28.9 L/s	**DIRECT MATCH**

Reference	Firebox / Inlet Size	Senf Measured Peak Flow	SR Calculated Peak Flow (10 Pa)	Agreement
Senf 09RUP (largest test unit)	22.5" firebox, ~22 in^2 inlet	~35 L/s (overfire)	SR-22: 35.3 L/s	**DIRECT MATCH**
SR-13 (smaller than any Senf test unit)	13" firebox, 13 in^2 inlet	Not tested (below Senf range)	SR-13: 20.9 L/s	**Below all Senf values - most conservative**

SR-18 calculated peak of 28.9 L/s confirms Senf's measured result of < 30 L/s for 18-inch test heaters. SR-22 calculated 35.3 L/s confirms the larger 22.5-inch unit result. The SR-13 requires no extrapolation.

7.2 Complete Air Flow Data: All SR Models Across Operating Pressures

All Solid Rock heaters deliver combustion air through the door system: 80% as overfire air through the integral air frame at the top of the door, 20% at the door base. Three chimney draft pressures are shown: 5 Pa represents a low burn or short chimney; 10 Pa is typical peak burn; 15 Pa represents a tall inside chimney on a very cold day, the most conservative case.

Model	Inlet Area	Total Flow @ 5 Pa	Total Flow @ 10 Pa (typical peak)	Total Flow @ 15 Pa	Overfire 80% @ 10 Pa	Underfire 20% @ 10 Pa	House Depress. @ 10 Pa	Under 5 Pa Limit?
SR-13	13 in^2	14.8 L/s	20.9 L/s	25.6 L/s	16.7 L/s	4.2 L/s	~2.1 Pa	**YES**
SR-18	18 in^2	20.5 L/s	28.9 L/s	35.4 L/s	23.1 L/s	5.8 L/s	~2.9 Pa	**YES**
SR-22	22 in^2	25.0 L/s	35.3 L/s	43.3 L/s	28.2 L/s	7.1 L/s	~3.5 Pa	**YES**
Senf (1994) measured	18 in^2	-	< 30 L/s	-	-	-	3 Pa (WO ODSIM)	**YES**
5 Pa Safety Limit (HDL)	-	-	-	-	-	-	**5.0 Pa max**	**LIMIT**

House depressurization scaled proportionally from Senf's WOODSIM result (30 L/s = 3 Pa in a tight R-2000 house, ELA = 0.02 m^2 at 10 Pa). SR values calculated using orifice flow equation (Q = Cd x A x sqrt(2dP / rho), Cd = 0.61, rho = 1.2 kg/m^3). The SR-22 at peak burn (35.3 L/s, ~3.5 Pa) remains 1.5 Pa below the safety threshold. Senf benchmark is directly measured; SR rows are calculated. Field testing planned for 2025-2026 will produce directly measured values.

8. Scenarios Where Makeup Air Deserves Consideration

The research is definitive for standard tight construction. The following scenarios warrant additional consideration:

- **Passive House / ICF construction below 1.5 ACH50:** These houses have essentially no incidental infiltration. Cumulative exhaust loads from range hood, bath fans, ERV, and dryer can combine with heater air draw to approach the 5 Pa limit. This is the gap in the 1994 data that field testing will address.
- **Other exhaust appliances operating simultaneously without dedicated makeup air:** Field experience from certified builders confirms that in tight homes, the more common real-world cause of heater back-draft is not the heater depressurizing the house. It is the heater operating as the path of least resistance when a range hood or bath fans pull the house below the 5 Pa threshold. Even at 1.35 ACH50, two 80 CFM bathroom fans running simultaneously can cause smoke spillage from the heater. A 250 CFM range hood without dedicated makeup air in a 0.6 ACH50 house will reliably back-draft any open wood-burning appliance. The correct solution in those cases is

makeup air to the exhaust appliance, which is outside the heater installer's control. Where that is not feasible, outside air to the heater room addresses the symptom.

- **Older underfire-air heater designs with a grate in the firebox floor:** These can draw up to 80 L/s and may approach or exceed the depressurization limit in tight houses.
- **Local code requirement:** Some U.S. jurisdictions have adopted outside air provisions for fireplaces that building officials may apply to masonry heaters. Always confirm with the Authority Having Jurisdiction.
- **Client preference:** A valid reason. The solutions in Section 9 address the concern safely.

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9. Practical Solutions That Avoid the Direct-Connect Hazard

9.1 Solution One: HRV or ERV Boost Mode During the Burn

Every tight home is built with an HRV (Heat Recovery Ventilator) or ERV (Energy Recovery Ventilator) for balanced mechanical ventilation. These units continuously bring fresh outside air in while exhausting an equal volume of stale air, recovering 70 to 80% of the exhaust heat in the process.

Running the HRV or ERV in boost mode for the duration of the burn, typically 2 to 3 hours, directly addresses house pressure balance. The boost function increases the fresh air intake rate, offsetting cumulative depressurization from the heater and all other exhaust appliances operating simultaneously. Most modern units include a boost button or timer on the wall controller specifically for this purpose.

> **Important note for HVAC designers and energy raters:** An HRV or ERV is a ventilation appliance, not a dedicated makeup air appliance. Running the HRV in boost mode addresses cumulative house depressurization by increasing the rate of balanced air exchange; it is not supplying dedicated makeup air to the heater. An unbalanced HRV can itself contribute to depressurization rather than relieving it. Self-balancing HRVs, now widely available, minimize that risk and should be specified in new construction with masonry heaters.
>
> For HVAC designers sizing a system for a house with a masonry heater, the heater should be included in the ventilation calculation as an intermittent exhaust load. Peak airflow for a properly designed overfire-air masonry heater ranges from approximately 44 CFM (20.9 L/s) for a smaller unit to approximately 75 CFM (35.3 L/s) for a larger unit, depending on firebox size and door configuration. The HRV must be capable of supplying at least that flow rate in boost mode during the burn cycle to maintain neutral house pressure.

Why this is superior to a direct-connect outside air duct:

- **Pre-tempered air.** The HRV/ERV recovers heat from outgoing exhaust before delivering fresh air. Instead of raw sub-zero air entering at floor level, supply air arrives at 45 to 55 degrees F even in extreme cold, eliminating the cold draft problem entirely.
- **No draft reversal risk.** Air is introduced through the HRV's own balanced duct system. There is no path for combustion gases to travel back through the makeup air supply.
- **Whole-house pressure management.** Boost mode addresses cumulative depressurization from all exhaust loads combined, which Gulland[5] identified as the only truly effective approach.
- **Zero additional construction cost.** Every tight home already has an HRV or ERV. This solution requires only that the client activate boost mode when lighting the fire.

Client instruction: When you load the heater and light the fire, activate the boost or recirculation mode on your HRV or ERV wall control. Leave it running for the full burn, typically 2 to 3 hours. When you close the chimney damper after the fire is out, return the unit to its normal operating mode. This single practice eliminates any residual concern about house depressurization during the burn cycle and requires no modification to your home.

9.2 Solution Two: Passive Cold-Air-Trap Makeup Air Detail

For clients or building officials who specifically want a physical makeup air supply, rather than or in addition to HRV boost mode, the following passive approach delivers fresh air without the wind-reversal hazard of a direct-connect firebox duct and without cold air flooding the living space.

A 6-inch insulated duct runs from the exterior to a floor-level or low-wall register in the room containing the heater. Critically, the duct incorporates a cold-air trap: a U-shaped low point near the exterior wall, sized so that cold air settling by gravity creates a natural thermal plug. This passive column of cold air does not actively enter the room; it is drawn through only when the heater's combustion pull creates sufficient negative pressure to overcome the thermal plug. Between burns, the trap prevents continuous cold air infiltration.

Key installation requirements:

- Supply outlet at floor level or no more than 12 inches above finished floor, in the heater room, not connected directly to the firebox.
- Closeable damper in the duct so the supply can be fully sealed when the heater is not in use. Place the damper as close to the building envelope penetration as possible to minimize the length of untempered cold duct inside the conditioned space.
- Exterior inlet on the windward side of the building at the lowest practical point, covered with corrosion-resistant screen, located below the typical snow line for the climate.
- Full duct insulation between the exterior penetration and the damper to prevent condensation on the pipe exterior and to minimize the cold air volume pre-filling the trap. In cold climates, uninsulated supply pipe running through conditioned space will collect condensation on the outside of the pipe. Slab-on-grade installations, where the supply pipe is embedded in the slab, are generally less prone to condensation because the slab partially tempers the pipe temperature.
- This arrangement eliminates the draft reversal risk: a floor-level room register cannot become a pathway for hot combustion gases traveling outward.

On intake location and wind pressure: Whether using a cold-air-trap detail or any other passive makeup air supply, the exterior inlet should always be on the windward side of the building, the side that sees positive wind pressure, and at the lowest practical point on that wall. This minimizes, though cannot eliminate, the probability of the intake seeing negative wind pressure during wind loading. It also reduces snow blockage risk. Senf's installation documentation specifies windward-side, lowest-point placement specifically for this reason.[3]

10. Decision Guide by Scenario

Scenario	Recommended Approach
Standard tight house, 2.0-5.0 ACH50, overfire-air heater, inside chimney	No outside air required. Room air is sufficient per formal research. Consider roughing in a 6-inch chase during construction for future flexibility at minimal added cost. CO detector required.
Ultra-tight construction, 0.6-1.5 ACH50 (Passive House, ICF, Net Zero)	Run HRV/ERV in boost mode for each burn cycle. Confirm the HRV can supply 44 to 75 CFM in boost mode to offset heater air draw. Optionally add a cold-air-trap makeup air register near the heater. Updated field testing by the author will provide definitive data for this scenario.
Concurrent exhaust appliances (range hood, bath fans) without dedicated makeup air	Address the exhaust appliance directly where possible; the heater is the path of least resistance when other appliances depressurize the house. Run HRV in boost mode during the burn. Optionally add a passive cold-air-trap detail near the heater as a supplemental measure.
Client wants assurance, no code requirement	Recommend HRV boost mode as standard practice. Optionally rough in a cold-air-trap supply detail near the heater.
Local building inspector requires outside air	Comply. Install 6-inch insulated duct with closeable damper placed near the envelope penetration, supply outlet at floor level near heater (not direct to firebox where possible), exterior inlet on windward wall at lowest practical point. Reference ASTM E1602 and this white paper.
Older underfire-air heater (grate in firebox floor)	Outside air intake advisable; these units can draw up to 80 L/s. Direct-connect supply should include a backflow damper and use heat-rated ducting.

11. Planned Field Testing: Closing the Gap for Ultra-Tight Modern Construction

The existing research base is sufficient to defend the current position for standard tight construction. To make this paper genuinely comprehensive for all modern construction types, particularly Passive House, ICF, and Net Zero builds, coordinated updated field testing is planned for the 2025-2026 heating season. A detailed testing proposal and protocol has been prepared separately.

The proposed testing program, coordinated by the author, will seek participation from certified masonry heater builders across North America to conduct standardized pressure measurements during actual burn cycles in a range of house tightness levels. Key elements:

- Three to five test sites representing a range of construction tightness, from standard tight (3.0 ACH50) to ultra-tight Passive House and ICF builds (0.6 ACH50), with at least two sites in the critical below-1.5 ACH50 range.
- Testing conducted by certified masonry heater builders during actual burn cycles using a calibrated digital micro-manometer to measure house depressurization at multiple points throughout the burn.
- Documentation of all concurrent exhaust loads during each test: HRV/ERV flow rate, range hood status, bath fans, clothes dryer.
- Direct measurement of heater airflow at the door inlet using a calibrated hot wire anemometer, to produce instrument-measured airflow values for comparison with the calculated values presented in Section 7.
- A sub-test at each site measuring house pressure with the HRV or ERV in boost mode versus normal mode, to directly validate the HRV-as-solution recommendation in Section 9.
- Results to be incorporated into an updated version of this paper, representing the most current and comprehensive evidence base available on this subject in North America.

Status: Field testing is planned for the 2025-2026 heating season. Certified masonry heater builders interested in participating, either by conducting tests on their own heaters or on heaters installed for clients, are encouraged to contact the author at Solid Rock Masonry Heaters. A detailed testing protocol document is available on request. Participating builders will be credited as contributors in the updated paper.

12. U.S. Building Code and Standards

Masonry heaters are addressed in IRC Section R1002. Custom site-built units must comply with ASTM E1602, Standard Guide for Construction of Solid Fuel Burning Masonry Heaters. This standard addresses outside air requirements specifically for masonry heaters and gives the Authority Having Jurisdiction flexibility to accept an overfire-air unit without a dedicated outside air supply under an alternative means and methods approval.

The U.S. EPA classifies masonry heaters as 'non-affected facilities' exempt from New Source Performance Standards certification, a recognition of their inherently clean, high-temperature combustion that also implicitly acknowledges their low air consumption rates relative to certified wood stoves.

13. Note for Building Officials

Masonry heaters should not be evaluated under wood stove or fireplace outside air provisions without reviewing the masonry heater-specific research. The key distinctions are:

- **Batch operation, not continuous:** A masonry heater burns for 2 to 3 hours per day. For the remaining 21 to 22 hours, no combustion occurs and no air is drawn from the house.
- **Air consumption:** Overfire-air masonry heaters consume under 30 L/s at peak burn, comparable to or less than a small conventional fireplace, and do not operate continuously.
- **Tailout safety:** Thermal mass maintains strong chimney draft well after the fire ends. Masonry heaters do not exhibit the tailout draft reversal risk that is the primary safety concern for outside air in conventional fireplaces.
- **Governing standard:** ASTM E1602, referenced in IRC Section R1002, governs custom masonry heaters and addresses outside air requirements specifically for this appliance type.
- **Code precedent:** Canada's National Building Code removed its mandatory outside air requirement after CMHC research showed it was ineffective. Current NBC requires only a CO detector for wood-burning equipment.

The author is an active member of ASTM Committee E06 and a certified masonry heater builder with the Masonry Heater Association of North America. Copies of all source documents referenced in this paper are available on request. The author is available to assist with permit review or to connect building officials with additional technical resources.

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