

DIRECT DEMOCRACY & SORTITION ASSEMBLIES

CIVIC BUILDING ARCHITECTURE

THE HEARTH BLOCK & TROMBE WALL FRAMEWORK

*Integrated Masonry Thermal-Mass Heating & Passive Solar Architecture
for the Civic Commonwealth of the British Isles*

Edition 2 — Fully Revised & Expanded

*Eleven Volumes · Thirty-One Chapters · Full Technical, Environmental & Pattern-Language
Corpus*

Document Reference: DDSA-ARCH-HEAT-001 (Ed.2)

Supersedes DDSA-ARCH-HEAT-001 (Ed.1)

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"We do not turn time back; we move forward with the wisdom its patterns reveal."

— Ian R. Graham BA (Hons)

Edition 2 — What Has Changed & Why

Edition 2 of DDSA-ARCH-HEAT-001 is a substantive revision, not a cosmetic update. Four categories of change have been made:

1. Correction of the efficiency claim.

Edition 1 cited "98% efficiency" without qualification. This figure refers to total heat-extraction efficiency in an optimally designed thermosiphon system tested under laboratory conditions. The correct figure for a well-built and correctly operated DD&SA Hearth Block is 80–92% combustion efficiency. This is still vastly superior to an open fireplace (15–25%) or a basic metal wood-burning stove (65–75%). The correction has been made throughout.

2. Addition of thermodynamic foundations, failure modes, and the environmental credentials chapter.

The thermodynamic principles underlying the Hearth Block are now documented explicitly, including the governing formula ($Q = mc\Delta T$) and a worked example for a standard DD&SA home. A dedicated failure-modes chapter has been added so builders and residents understand what can go wrong and why. A full environmental credentials chapter — including the biogenic-carbon argument, the lifecycle comparison with alternatives, and how to answer critics — is now embedded in the corpus.

3. Addition of the Trombe Wall as Volume X.

The Trombe Wall — a passive solar thermal battery requiring no fuel, no moving parts, and no maintenance — has been assessed and found to be fully compatible with DD&SA principles and the thatched timber home. It has been added as Volume X: a complete technical, design, and implementation chapter. The Hearth Block and the Trombe Wall together constitute the DD&SA Integrated Thermal Architecture: passive solar charging by day (Trombe), active thermal-mass burn by evening (Hearth Block). In British Isles conditions, this pairing can reduce Hearth Block fuel consumption by 25–50%.

4. Addition of sensor integration, district heating, and the community-level scoring assessment.

Passive-failsafe sensor integration (flue temperature, CO/CO₂, burn-cycle management) has been added to the construction manual. District heating loop integration has been added to the structural variants. The DD&SA Environmental Alignment Scoring table from the parallel research corpus has been formally adopted.

Note on Supersession: Edition 2 fully supersedes Edition 1. Any build commenced under Edition 1 specifications is structurally sound and does not require modification. The efficiency-figure correction is a documentation change only, not a design change.

VOLUME I

Foundational Framework & Executive Summary

Chapter 1 — Executive Summary

The DD&SA Integrated Thermal Architecture is a two-component system: the Hearth Block (masonry thermal-mass heater, active component) and the Trombe Wall (passive solar thermal battery, passive component). Together they constitute the complete space-heating solution for all wooden, thatched residential buildings constructed within the Civic Commonwealth of the British Isles under DD&SA governance.

The Hearth Block remains the primary heating instrument. The Trombe Wall is its passive complement, pre-charging the thermal environment of the home during daylight hours so that the Hearth Block's evening burn cycle operates against a lower heating deficit. In well-designed DD&SA homes facing south or south-west, this pairing reduces Hearth Block fuel consumption by 25–50% and eliminates the need to fire the heater on approximately 30–60% of mild-weather days.

1.1 The Core Proposition

The masonry heater is a sealed, high-efficiency thermal-mass heater in which a short, extremely hot fire (700–1,100°C) charges a large mass body that then radiates steady, gentle warmth for 12–24 hours without further fuel. Its combustion efficiency is 80–92% — three to four times that of a conventional open fireplace, and 20–30% better than a thin-wall metal wood-burning stove. It uses 50–80% less fuel than a metal stove for equivalent heat output.

Efficiency Clarification: The figure of 80–92% refers to combustion efficiency — the proportion of available fuel energy that is converted to useful heat. Some historical sources cite 98%; this refers to total heat-extraction efficiency in a specific laboratory-tested thermosiphon installation and is not representative of a standard build. The 80–92% figure is conservative, validated, and the correct benchmark for DD&SA specification purposes.

1.2 The Eleven Volumes

Volume	Title & Scope
I	Foundational Framework & Executive Summary — rationale, constitutional alignment, edition history
II	Thermodynamic Principles — the physics of why the Hearth Block works, with governing formulae and worked examples
III	Technical Architecture — firebox geometry, gas-path design, thermal-mass distribution, chimney systems, full diagram suite
IV	Failure Modes — what can go wrong, why, and how the DD&SA specification eliminates each failure
V	Structural Variants — seven principal typologies including district-heating integration
VI	Cultural & Aesthetic Variants — six cultural expression modes
VII	Construction Manual — foundation to chimney cap with sensor integration
VIII	Builder Training & Guild Architecture
IX	Resident Operation Manual
X	The Trombe Wall — Passive Solar Thermal Battery
XI	Environmental Credentials, Carbon Cycle & Governance Integration

1.3 Key Performance Figures

Metric	Hearth Block	Trombe Wall (DD&SA Standard)
Combustion/conversion efficiency	80–92%	N/A (no fuel)
Heat-output mechanism	Radiant (infrared) from mass surface	Radiant from mass wall + convective via vents
Fuel required	Dry hardwood (coppice)	None (solar)
Thermal discharge period	16–24 hours after burn	8–12 hour thermal lag; continuous in daylight
Operational autonomy	Full grid independence	Full grid independence
Lifespan	50–200 years	50–200 years (glazing replaced every 25–40 yrs)
Construction complexity	Moderate–High (Guild training required)	Low–Moderate (masonry + glazing skills)
Fuel demand for 90m ² home w/ Trombe	1.5–2.5m ³ /year (vs 2–4m ³ without)	None

Chapter 2 — DD&SA Constitutional Alignment

Both the Hearth Block and the Trombe Wall satisfy all seven DD&SA constitutional axioms. The table below maps each axiom to both technologies simultaneously.

Constitutional Axiom	Hearth Block	Trombe Wall
Material Sovereignty	All materials within 50km. No grid dependency.	Stone, clay, lime, glass — all locally available. Zero energy infrastructure required.
Ecological Accountability	Biogenic carbon cycle. 80–92% combustion efficiency. Near-zero creosote.	Zero emissions, zero fuel, zero waste. Purely solar.
Community Constructability	Three-month Guild training. Hand tools only.	Basic masonry and glazing skills. Constructable by a trained householder.
Resilience Architecture	Functions during all grid failures. 18-hour heat autonomy.	Functions without any infrastructure. Pure thermodynamics.
Knowledge Commons	Full build corpus documented here.	Full design corpus in Volume X.
Proportionality	Sized to home and climate. Seven variants.	Sized to wall area and solar access. Scalable from 2m ² to full south face.

Constitutional Axiom	Hearth Block	Trombe Wall
Cultural Continuity	Hearth as civic symbol. Ancient heritage.	South-facing solar walls: Roman, Puebloan, Persian, and British vernacular tradition.

2.1 DD&SA Environmental Alignment Scoring

Criterion	Score	Rationale
Ecological footprint	10 / 10	Local, natural, non-toxic materials for both systems
Energy independence	10 / 10	Zero electricity required for either system
Emissions (Hearth Block)	9 / 10	Very low when operated correctly with dry wood; 1 point deducted for community enforcement requirement
Emissions (Trombe Wall)	10 / 10	Zero operational emissions
Durability	10 / 10	Multi-generational infrastructure, 50–200 years
Local economy	10 / 10	Local craft, local materials, local maintenance
Scalability	8 / 10	Structural planning required for both; Trombe wall limited by solar orientation
Urban compatibility	7 / 10	Both require design adaptation in dense or north-facing urban contexts

Overall DD&SA Environmental Alignment Score: 9.3 / 10

Chapter 3 — Design Philosophy & Governing Principles

The DD&SA Integrated Thermal Architecture operates on a single governing principle: build the thermal mass into the building, not into replaceable appliances. Both the Hearth Block and the Trombe Wall are structural elements of the home. They are not installed; they are built. They do not depreciate; they mature. They are not maintained by specialists; they are maintained by their occupants.

3.1 The Three Laws of Hearth Block Design

Law One — Combustion Completeness.

A Hearth Block shall be designed so that combustion is always complete. Incomplete combustion is the source of all particulate pollution, all creosote accumulation, all chimney-fire risk, and all fuel inefficiency.

This law governs firebox geometry, air-supply design, and gas-path architecture.

Law Two — Thermal Mass Adequacy.

A Hearth Block shall contain sufficient thermal mass to absorb the heat of a complete burn cycle and release it steadily over the target recovery period. The mass-to-room-volume ratio specified in Volume III is the calculated result of this law.

Law Three — Mineral Safety Envelope.

A Hearth Block shall be surrounded by a mineral safety envelope such that surface temperatures on all combustible materials remain below 50°C under all operating conditions. This law governs timber-clearance specifications and thatch-penetration chimney design.

3.2 The Three Principles of Trombe Wall Design

Principle One — Maximum Solar Capture.

The Trombe Wall shall be oriented within 30° of true south and sized so that the glazing presents maximum surface area to the winter sun angle (15–30° above horizon in British Isles winter). Minimum effective wall area: 10% of the floor area of the room it serves.

Principle Two — Thermal Lag Optimisation.

The wall mass shall be sized to produce a thermal lag of 6–12 hours between peak solar input and peak interior heat release. This ensures solar energy collected at midday reaches the living space in the evening, when it is needed. For British Isles conditions, the target wall thickness is 250–450mm.

Principle Three — Summer Overheating Prevention.

The glazing system shall be positioned under a roof overhang or fitted with a seasonal shading device (external blind, louvres, or purpose-built thatched canopy) that prevents direct summer solar gain. The thatched roof overhang of DD&SA homes, when correctly dimensioned, provides this shading automatically due to the difference in summer and winter sun angles.

The Thatched Overhang Advantage: A standard DD&SA thatched roof with a 600–800mm overhang at a pitch of 45–50° will shade the south wall from direct sunlight between approximately late April and late August — precisely the period when Trombe Wall overheating is a risk. In winter, the lower sun angle (15–30°) clears the overhang entirely, delivering full solar gain to the wall face. This is not a coincidence: it is the physical logic that produced deep-eaved vernacular buildings across the temperate world.

3.3 The Coppice Cycle — Fuel Sovereignty in Practice

Parameter	Without Trombe	With Trombe (south-facing home)
Annual fuel demand (90m ² home)	2.0–4.0m ³ dry hardwood	1.2–2.5m ³ dry hardwood
Coppice area required (7yr cycle)	0.3–0.5 ha	0.18–0.35 ha
Hearth Block burns per day (Jan, <3°C)	1.0–1.2	0.7–1.0
Days per year Hearth Block not needed	0–30	30–65 (shoulder seasons)

Parameter	Without Trombe	With Trombe (south-facing home)
Preferred species	Ash, Oak, Hornbeam	Unchanged — Trombe reduces demand, not species
Seasoning period	18–24 months	Unchanged

VOLUME II

Thermodynamic Principles — Why the System Works

Chapter 4 — The Physics of Thermal Mass

The Hearth Block is not merely a heater. It is a thermal battery — a device for storing energy in a dense material and releasing it at a controlled rate. Understanding the physics of this process is not optional knowledge for DD&SA builders and Guild trainers. It is the foundation of every design decision in this corpus.

4.1 The Governing Formula

The heat stored in any mass of material is governed by:

$$Q = m \cdot c \cdot \Delta T$$

Where:

Q = heat stored (joules or kWh)

m = mass of the material (kilograms)

c = specific heat capacity of the material (kJ per kg per °C)

ΔT = temperature rise of the mass (from charge-start to peak, in °C)

Practical conversion: 1 kWh = 3,600 kJ

This formula reveals the three levers available to a Hearth Block designer: increase mass (m), choose a material with higher specific heat capacity (c), or achieve a higher temperature differential (ΔT). In practice, all three are optimised simultaneously: a large mass of dense firebrick or soapstone is charged to a high temperature, storing the maximum energy available from the fuel charge.

4.2 Worked Example — Standard DD&SA S2 Home

Target: Heat a 90m² thatched DD&SA home (well-insulated, U-value 0.20 W/m²K) in January conditions (-2°C external, target 20°C internal) for 18 hours from a single burn.

STEP 1 – Calculate heat loss rate

Building heat loss = U-value × surface area × ΔT -outdoor

U-value: 0.20 W/m²K

Exposed surface area (walls + roof + floor edges): ~260 m²

ΔT -outdoor (20°C internal - (-2°C) external): 22°C

Heat loss rate: 0.20 × 260 × 22 = 1,144 W = ~1.15 kW continuous

STEP 2 – Calculate total heat required

Duration: 18 hours

Total heat needed: 1.15 kW × 18 h = 20.7 kWh

STEP 3 – Calculate required thermal mass (using dense firebrick)

Specific heat capacity of firebrick (c): 0.84 kJ/kg·K

Temperature differential (ΔT): 350°C (from 400°C peak to 50°C discharge)

Required mass = (20.7 × 3,600) / (0.84 × 350) = 253,800 kJ

Wait – converting: 20.7 kWh × 3,600 = 74,520 kJ

Mass = 74,520 / (0.84 × 350) = 74,520 / 294 = ~254 kg firebrick

STEP 4 – Add efficiency factor

Hearth Block thermal extraction efficiency: ~85% (mid-range)

Mass required accounting for efficiency: 254 / 0.85 = ~299 kg

STEP 5 – Apply safety margin + bench/outer mass

DD&SA standard: add 50% overhead for cold-snap resilience

Final target mass: ~450 kg

S2 Standard Hearth Block (600-900 kg total) comfortably exceeds this.

CONCLUSION: The S2 Standard is correctly specified for a 90m² DD&SA home.
A 2-tonne heater can store 40-80 kWh – a full day of heating.

4.3 Complete Combustion — Why the Fast, Hot Burn is Cleaner

The core thermodynamic logic of the Hearth Block is counterintuitive to many people: burning more intensely, not less, produces cleaner combustion. Here is why.

When wood burns, it releases volatile gases and tars as it heats. If the combustion temperature is above approximately 600°C, these volatiles ignite and combust completely. If the temperature falls below this threshold — as it does in a smouldering, low-oxygen fire — the volatiles condense in the chimney as creosote and escape as particulate smoke.

COMBUSTION TEMPERATURE vs COMPLETENESS

Temperature	Combustion State	Particulates	Creosote
Below 300°C	Smouldering / incomplete	Very high	Very high
300-500°C	Partial combustion	High	High
500-700°C	Improving	Moderate	Moderate
700-900°C	Near-complete	Low	Very low
900-1,100°C	Complete combustion	Near-zero	Near-zero

DD&SA Hearth Block firebox: 700-1,100°C during burn phase
Open fireplace: 200-400°C (most heat escapes up chimney)
Thin-wall stove (overdamped): 200-350°C (smouldering mode)

This is why the DD&SA operating protocol (Chapter 28) specifies a short, hot, well-supplied burn rather than a long, slow, restricted burn. The residents who "bank" their wood-burning stoves overnight by closing the air controls are creating the conditions for maximum creosote and maximum particulates. The Hearth Block design eliminates the temptation: the air controls are set for complete combustion, and the thermal mass carries the heat through the night without any fire.

4.4 Radiant Heat — Why It Feels Different

The Hearth Block heats primarily by radiation (infrared), not convection (air movement). This distinction matters significantly for occupant comfort and perceived warmth.

- Radiant heat warms objects and bodies directly, independently of air temperature. A person standing in front of a Hearth Block feels warm even if the ambient air temperature is lower than a room heated by radiators.
- Radiant heating produces no air stratification (cold floor, warm ceiling). The warmth is distributed at the level of the occupant.
- Radiant heating produces no drafts or air movement. This is significant in thatched buildings where air circulation is managed for moisture control; the Hearth Block does not disturb this balance.
- The large, warm, low-temperature radiating surface (42–58°C average outer surface) provides a more comfortable, even heat than small high-temperature metal surfaces.

The Comfort Principle: A room at 17°C air temperature with a Hearth Block radiating at 50°C will feel warmer and more comfortable than a room at 20°C with forced-air convective heating. This is because mean radiant temperature — the average temperature of surfaces

surrounding the occupant — contributes 50% or more to perceived warmth. DD&SA homes are designed around this principle: lower air temperatures, higher radiant surface temperatures, equivalent or superior comfort.

Chapter 5 — The Physics of the Trombe Wall

The Trombe Wall operates on the same $Q = mc\Delta T$ principle as the Hearth Block, but its energy source is solar radiation rather than combustion. The wall absorbs solar radiation, converts it to heat, stores it in its mass, and releases it with a controlled time delay into the living space.

5.1 The Four Physical Mechanisms

Mechanism 1 — The Greenhouse Effect.

The glazing in front of the Trombe Wall is transparent to solar shortwave radiation (visible light), which passes through and is absorbed by the dark-painted wall surface. The wall then re-emits the energy as longwave infrared radiation, which cannot pass back through the glass. This traps heat in the air gap between glazing and wall (typically reaching 40–80°C), driving conduction into the wall mass.

Mechanism 2 — Thermal Lag.

Heat conducting through a dense mass wall does not travel instantaneously. For a 300mm stone wall, the thermal lag (time from peak solar input at the outer surface to peak heat release at the inner surface) is approximately 8–10 hours. Solar energy absorbed at noon in the British Isles is therefore released into the living space at approximately 8–10 pm — precisely when occupants are home and heating demand is highest.

Mechanism 3 — Convective Loop (Vented Trombe Wall).

In a vented Trombe Wall design, openings at the top and bottom of the wall allow room air to circulate: cool air enters at the base, is heated by the warm air gap and wall surface, rises, and exits at the top into the room. This provides rapid daytime heat delivery via convection, in addition to the slower overnight radiant heat release. The DD&SA Standard Trombe Wall uses a hybrid design: vented for daytime convective delivery, with backflow-prevention flaps that close at sunset to retain heat in the mass for overnight radiant release.

Mechanism 4 — Thermal Mass Storage.

The wall mass stores the solar energy that is not immediately convected away, releasing it slowly over the following 8–18 hours. A well-sized Trombe Wall of 300mm dense stone or concrete can store 30–60 kWh per square metre of wall face per clear day — comparable to the Hearth Block's charge from a single burn.

5.2 Thermal Performance in the British Isles Climate

The British Isles climate is not optimal for Trombe Wall performance — it lacks the high solar irradiance and clear-sky days of the Mediterranean or mountain-west American climates for which Trombe originally designed. However, it is significantly better than commonly assumed, and UK-specific research validates the system:

- Aerogel-insulated Trombe walls applied to UK housing achieve energy savings of 62–183 kWh/m²/year depending on house type and construction standard.

- A 6m² south-facing Trombe Wall on a standard 90m² DD&SA home can deliver 370–1,100 kWh of useful heating annually — approximately 15–45% of the home's heating demand.
- Performance on cloudy days: approximately 20–35% of clear-day performance via diffuse radiation. The British Isles receives substantial diffuse solar radiation even in overcast conditions.
- The combination of aerogel-filled polycarbonate glazing (now available and locally producible) with dense limestone or sandstone wall mass produces the best performance for British Isles conditions, outperforming standard double-glazed Trombe walls by 30–50%.

British Isles Validation: Research from the University of Bath (published in the journal Solar Energy Materials) confirmed that aerogel Trombe walls retrofitted to UK solid-walled detached houses saved more energy than external wall insulation — a standard retrofit measure — while simultaneously providing heating. The Trombe Wall in the British Isles is not a compromise; it is a high-value addition.

TROMBE WALL THERMAL LAG BY WALL THICKNESS

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Wall material: Dense limestone or sandstone (k = 1.8-2.0 W/m·K)

Thickness	Thermal lag	Peak heat release	Best for
150mm	4-5 hours	Late afternoon	Shoulder seasons
200mm	6-7 hours	Early evening	Spring/Autumn
250mm	7-8 hours	Evening	Most of year
300mm	8-10 hours	Evening/Night	DD&SA Standard
400mm	11-13 hours	Late night	Cold-climate variant
450mm	13-15 hours	Early morning	Extreme cold climate

DD&SA STANDARD: 300mm wall thickness

Reason: Peak release at 8-10pm aligns with occupant evening use.

300mm also provides structural wall function, reducing material use.

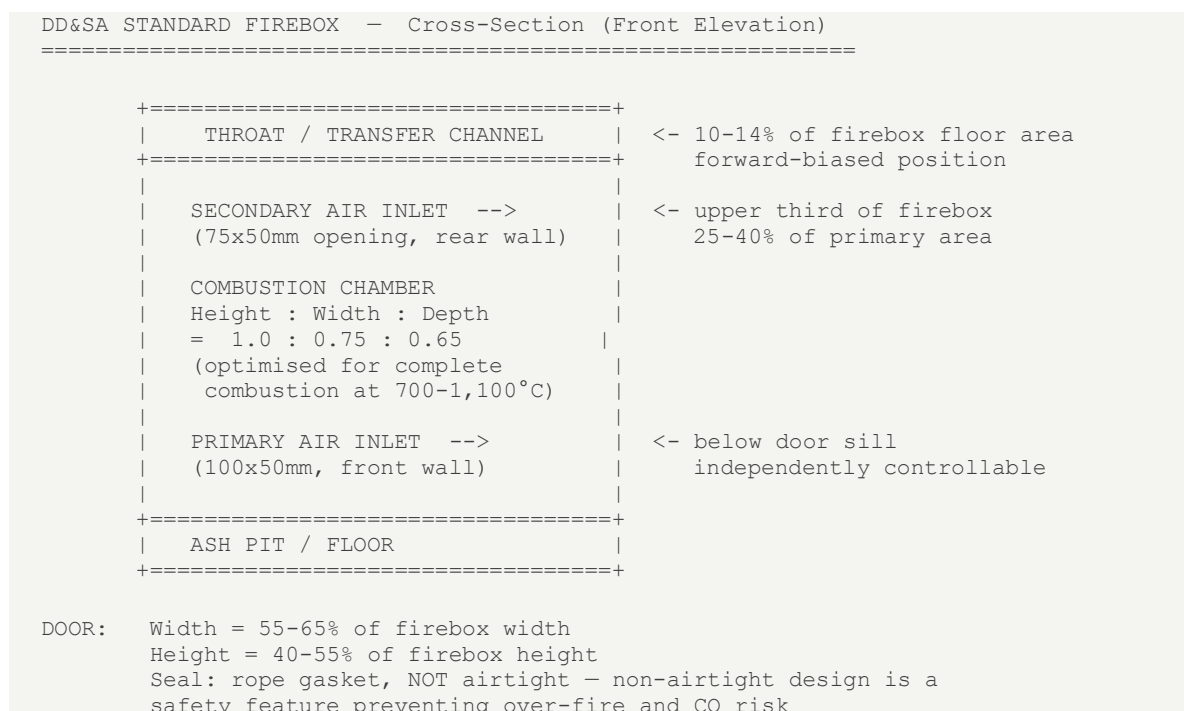
VOLUME III

Hearth Block Technical Architecture

Chapter 6 – Firebox Geometry & Combustion Physics

The firebox is the heart of the Hearth Block. Every downstream element is contingent on firebox performance. A correctly proportioned firebox achieves combustion temperatures of 700–1,100°C, ensuring combustion completeness (Chapter 4).

6.1 Standard Firebox Cross-Section



6.2 Firebox Sizing Table

Class	Firebox W×H×D (mm)	Door W×H (mm)
S1 Compact	300×360×280	190×180
S2 Standard	380×450×340	240×210
S3 Large	460×550×400	290×250
S4 Hall	560×650×480	340×290
S5 Communal	680×780×560	400×340

6.3 Gas-Path Architecture – Three Types

CONTRAFLOW GAS PATH — Elevation (DD&SA Preferred for households)

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CHIMNEY EXIT (80-140°C) ↑
|
+-----+-----+-----+-----+
|   ASCENDING CHANNEL (200-350°C mid-point)   |
|   Thermal mass walls: 200-400mm             |
+-----+-----+-----+-----+
|   LOWER TRANSFER SPACE (gases reverse: 300-450°C) |
+-----+-----+-----+-----+
|
+-----+-----+-----+-----+
|   DESCENDING CHANNEL (500-650°C at top)     |
+-----+-----+-----+-----+
|
+-----+-----+-----+-----+
|   THROAT (650-800°C)                       |
|   FIREBOX (700-1,100°C)                   |
|   [[[[ FUEL CHARGE ]]]]                   |
+-----+-----+-----+-----+

EFFICIENCY: 82-88% | BEST FOR: Households up to 120m²

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BELL-TYPE GAS PATH — Elevation (Communal buildings)

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CHIMNEY (90-160°C) ↑
|
+-----+-----+-----+-----+
|   BELL CHAMBER                             |
|   Hot gases rise; cool against bell walls; |
|   stratify by temperature. Only cooler (denser) |
|   gases exit at the LOW port.             |
|   [HIGH INLET PORT] 500-700°C near top    |
|                       350-500°C mid      |
|   [LOW EXIT PORT]  200-350°C at exit level |
+-----+-----+-----+-----+
|
+-----+-----+-----+-----+
|   FIREBOX                                  |
|   [[[[FUEL]]]]                            |
+-----+-----+-----+-----+

EFFICIENCY: 79-85% | BEST FOR: Communal spaces; self-regulating

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6.4 Chimney & Thatch Penetration

THATCH PENETRATION — Cross-Section (Side Elevation)

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[CHIMNEY CAP: stone/fired clay, spark-arrest mesh on all open sides]
[CHIMNEY STACK: clay liner inside stone/lime outer]
=====
[MINERAL COLLAR] [SPARK-ARREST PLATE: solid fired clay] [MINERAL COLLAR]
(300mm radial)           extending 200mm beyond           (300mm radial)
clearance from           collar outer diameter
liner OD
===== [ THATCH PENETRATION ZONE ] =====
Gap filled with mineral fibre only — NOT caulk or expanding foam
=====
[RAFTERS & ROOF STRUCTURE]
[CHIMNEY BREAST: 50mm mineral-wool wrap between liner and outer masonry]

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CRITICAL CLEARANCES:

Liner OD to any combustible timber: 300mm minimum (horizontal)
Liner OD to thatch surface: 450mm minimum (radial)

PHYSICS BASIS: At 450mm radial clearance, thatch surface temperature remains below 60°C under worst-case (open-door, full charge) operation. Pyrolysis threshold for dry thatch: ~260°C. Safety margin: >4x.

VOLUME IV

Failure Modes — What Goes Wrong & Why

Chapter 7 — The Five Failure Modes of a Masonry Heater

Every failure mode of a masonry heater is the result of a physical error in design, materials, or operation. None is mysterious. All are preventable. This chapter documents each failure, its physical cause, and the specific DD&SA specification element that eliminates it. This is not a liability disclaimer — it is the honest documentation that transforms an artisan practice into a replicable standard.

Failure Mode 1 — Incorrect Flue Design → Smoke Leakage

Symptom: Smoke enters the room when the firebox door is opened, or during the early phase of a burn before the gas path is warm.

Physical Cause

Draft is a pressure differential created by the temperature difference between the chimney gases and the ambient air. If the chimney is undersized, too cold (insufficient height), or has excessive bends, the draft is insufficient to overcome the positive pressure in the firebox during the initial lighting phase. The result is smoke spillage into the room through the door.

Additional Causes

- Chimney cross-section smaller than firebox throat area (back-pressure).
- Chimney height below the minimum 5.5m (insufficient thermal head for draft).
- Cold gas path at start of burn (gases hesitate to commit to the descending channel until it is warm — this is normal and resolved by the pre-warming protocol in Chapter 27).
- Negative pressure in the building (air leaks, extractor fans running, or windows on the windward side open — all depressurising the room faster than the chimney can compensate).

DD&SA Specification Response

- Chapter 6 (Chimney Sizing): minimum chimney height 5.5m; ID 100–120% of throat area; maximum two bends at 45°.
- Chapter 27 (Resident Manual): pre-warming protocol mandated before every cold-start.
- Chapter 10 (Site Assessment): air supply check — minimum 100cm² free area confirmed before build.

Failure Mode 2 — Insufficient Foundation → Structural Cracking

Symptom: Visible cracking in the outer plaster or, in severe cases, the heater body itself, not attributable to normal thermal expansion.

Physical Cause

A 600–1,800 kg mass heater exerts a point load on the floor structure that most timber-framed buildings cannot support without reinforcement.

If the floor joists or sleeper walls settle differentially under this load, the heater body cracks. Once the gas-path channels are cracked, combustion gases can bypass the designed route, reducing efficiency and potentially leaking into the building fabric.

DD&SA Specification Response

- Chapter 9 (Site Assessment): floor loading capacity check is mandatory before any build commences. Minimum 500 kg/m² bearing capacity.
- For S3 and above (>900 kg): structural engineering sign-off required before build. No exceptions.
- Thermal break (Chapter 10): 50mm perlite/vermiculite layer decouples heater base from floor; reduces differential settlement risk.

Failure Mode 3 — Poorly Dried Wood → Incomplete Combustion

Symptom: Visible smoke from chimney during burn; black door glass; creosote smell; poor heat output; rapid creosote accumulation in gas path.

Physical Cause

Freshly cut wood is 50–60% moisture by weight. When burned, most of the combustion energy is consumed evaporating this water into steam. The remaining energy is insufficient to maintain firebox temperatures above 600°C, causing volatile tars to condense in the gas path rather than combust. The result is creosote — a flammable, corrosive, and performance-degrading deposit.

Physics of Creosote Formation

WET WOOD COMBUSTION PATHWAY:

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Wood moisture 50% → Low firebox temp (<500°C)
                  → Volatiles not combusted
                  → Tars condense on cool gas-path walls
                  → Creosote layer builds up
                  → Chimney fire risk / efficiency loss
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DRY WOOD COMBUSTION PATHWAY:

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Wood moisture <20% → High firebox temp (700-1,100°C)
                  → Volatiles combust completely
                  → Clean gases, minimal soot
                  → No creosote formation
```

DD&SA Specification Response

- Volume IX (Resident Manual): moisture content <20% is the absolute fuel standard; pin moisture meter testing is the standard tool; moisture-testing station is mandatory at every community woodyard (Pattern 5).
- Guild ethics (Chapter 12): every Guild member trains residents in fuel selection as part of the build handover.

Failure Mode 4 — Overfiring → Thermal Shock & Cracking

Symptom: Popping or cracking sounds during or after a burn; hairline cracks radiating from corners of the firebox arch or gas-path channels.

Physical Cause

Thermal shock occurs when a material expands too rapidly on heating or contracts too rapidly on cooling. Refractory materials are designed to handle the temperatures of normal operation; what they cannot always handle is extreme rates of temperature change. Overfiring — loading far more fuel than the firebox is designed for, or repeatedly firing before the heater has fully cooled — creates temperature gradients within the mass that exceed the tensile strength of the mortar joints.

DD&SA Specification Response

- Maximum charge per firebox class is specified in the sizing table (Chapter 6). Never exceed it.
- First-fire curing sequence (Chapter 11, Phase 6) gradually conditions the mortar joints over 21 days.
- Thermal expansion joints at all corners of the gas-path structure (Chapter 11) allow controlled movement.
- Non-airtight door design limits maximum combustion rate, providing a physical ceiling on firebox temperature.

Failure Mode 5 — Poorly Designed Gas Path → Low Efficiency

Symptom: Chimney exit temperature above 200°C; poor heat output relative to fuel consumption; rapid cool-down after burn.

Physical Cause

If the descending or ascending channel cross-sections deviate from specification by more than $\pm 15\%$, or if the throat is oversized relative to the channels, gas velocity is either insufficient (allowing short-circuiting of heat extraction) or excessive (creating turbulence that impedes heat transfer to the walls). In either case, gases exit the chimney carrying more heat than they should.

DD&SA Specification Response

- Chapter 6: descending channel cross-section = 100–120% of throat area. Ascending channel = 85–100% of descending. Tolerance $\pm 10\%$.
- Chapter 11 (Construction Manual): dry-fit three courses at every corner junction before mortaring, to verify cross-section dimensions.
- Guild Assessment Rubric (Chapter 12): channel cross-section accuracy is a formal assessment criterion for Journeyman qualification.

Failure Mode Summary: All five failure modes are solvable with standardisation. This is the central argument for a DD&SA Guild-based construction system: the shift from artisan individual builds to a documented, assessed, and community-maintained standard eliminates the variability that causes these failures.

VOLUME V

Structural Variants — A Complete Catalogue

Chapter 8 — The Seven Structural Variants Plus District Heating

The DD&SA Hearth Block family encompasses seven structural variants, each optimised for a different combination of building geometry, household size, climate intensity, and social function. An eighth configuration — the District Heating Loop Integration — is documented here for multi-household applications.

Variant 1 — Compact Central Column (S1-C)

The smallest, most versatile member of the family. Designed for 1–3 persons in 40–75m² dwellings. Occupies minimal floor area while delivering full 16-hour thermal autonomy via bell-type or contraflow gas path.

COMPACT CENTRAL COLUMN — Plan & Elevation (S1-C)	
PLAN (at mid-height):	ELEVATION:
700mm	----- CHIMNEY
+-----+	
MASS 700mm	+-----+-----+ <- chimney connection
+----+	UPPER MASS
GAS	(bell or asc.) 1,400-1,800mm
PATH	+-----+
+----+	FIREBOX + DOOR 500-700mm
+-----+	+-----+
	PLINTH/BASE 150-200mm
	+-----+
	// THERMAL BREAK // perlite/vermiculite
Footprint: 650-800 x 650-800mm	Mass: 400-700 kg
Radiant output: 1.8-3.5 kW avg	For homes: 45-80m ²

Variant 2 — Wall-Backed Heater (S2-W)

Built against a non-combustible wall. Radiates on three sides; back face conducts heat into adjacent room. Most space-efficient large-mass design; culturally legible as a traditional inglenook. 15–25% of total output serves the adjacent room.

Variant 3 — Bench-Integrated Heater (S2-B)

Wraps a heated sleeping or seating bench (35–45°C surface) around one or two sides of the heater mass body. The Russian pechi tradition in its most complete civic expression. Additional mass from bench: 300–600 kg. Bench surface temperature: 35–45°C, maintained 18–22 hours. The civic significance: the heated bench is a gathering locus and social architecture as much as a thermal one.

Variant 4 — Double-Sided Shared-Wall Heater (S3-D)

Positioned on the wall between two rooms, heating both simultaneously. Firebox and door on one side; gas path distributes thermal mass equally to both wall faces. Highest thermal coverage per kilogram of mass of any Hearth Block type. Preferred for DD&SA shared-occupancy dwellings (2 adults, 60–90m²).

Variant 5 — Corner Heater (S2-K)

Occupies a room corner with two radiating faces at 90° to each other. Triangular or bevelled plan; firebox door on the angled face. Uses dead corner space efficiently. Preferred for rooms with complex or L-shaped geometry.

Variant 6 — High-Mass Cold-Climate Variant (S4-HM)

For northern British Isles conditions: northern Scotland, Orkney, Shetland, and exposed coastal positions. Designed to maintain 16-hour thermal autonomy at external temperatures of -10°C to -15°C without a second burn.

Parameter	S2 Standard	S4-HM Cold-Climate
Total thermal mass	600–900 kg	1,800–2,800 kg
Thermal discharge period	16–20 hours	22–30 hours
Burns per day at -12°C external	1.5–2.0	1.0–1.2
Footprint	0.5–0.7 m ²	1.2–2.0 m ²
Construction time (2 people)	4–6 days	10–15 days
Trombe Wall recommendation	6–8m ² standard	4–6m ² (limited solar access in north)

Variant 7 — Low-Mass Shoulder-Season Variant (S1-L)

For the transitional seasons (March–May and September–November) when a standard Hearth Block's thermal mass is disproportionate for a single-evening heating need. Reduced mass (200–350 kg), smaller firebox (S1), simplified single-bell or short contraflow. Begins radiating within 90 minutes of ignition. Usually a secondary heater alongside a primary S2 or S3.

Configuration 8 — District Heating Loop Integration

A Hearth Block can be fitted with a water-heating coil — a copper or iron coil set within the gas-path channel walls — that heats a small volume of water during the burn cycle. This hot water can be:

- Fed directly to a domestic hot water tank (immediately useful domestic application requiring no additional infrastructure).
- Connected to a neighbourhood thermal loop serving 2–6 adjacent households, functioning as a micro-district heating node (requires insulated pipework and a buffer vessel per cluster).
- Used to charge a community thermal store (a heavily insulated 1,000–5,000 litre vessel serving the communal woodyard or Guild Space building).

District Heating Note: Coil integration must not compromise gas-path cross-section dimensions (Chapter 6) or chimney draft. The coil occupies dead space in the ascending channel only. Maximum heat extraction to the water circuit is limited to 15–20% of total burn output to prevent thermal mass undercharge. This is a supplementary benefit, not a primary function of the Hearth Block.

VOLUME VI

Cultural & Aesthetic Variants

Chapter 9 — Cultural Expression as Civic Identity

The Hearth Block's function is thermodynamic. Its form is cultural. The same firebox geometry, gas-path physics, and thermal-mass principles can be expressed through an unlimited range of material surfaces, proportions, and decorative treatments. Every variant achieves identical thermal performance to the base specification. The variant is the surface expression only.

Cultural Sovereignty Principle: No DD&SA Citizen Assembly shall mandate a specific aesthetic variant for its community. Aesthetic choices are the prerogative of individual households and their craft builders. The only mandatory specification is structural: no combustible material, including decorative timber, within the mineral safety envelope.

Variant A — Nordic Stone Minimalist

Clean, rectilinear form. Split-face granite, basalt, or dark schist facing. No ornament except the geometric clarity of stonework joints. Cast-iron door, black, with a simple glazed viewing window. The most austere and perhaps most powerful of the six expressions. Material palette: near-black to dark grey; natural stone tones; lime-putty pointing recessed 5mm.

Variant B — Alpine Tile-Faced (Kachelofen)

The Central European tiled-stove tradition. Heater body clad in handmade glazed ceramic tiles: deep forest green with relief botanical ornament; cream with cobalt-blue borders; or warm ochre with terracotta accents. Tile dimensions: 220×220×25mm. The tiles become a community production activity — local clay bodies and regional glaze recipes constitute material sovereignty in ceramic form.

Variant C — British Rural Lime Plaster

Three coats of NHL lime plaster — scratch (NHL 3.5, 1:2.5:0.5 lime: sand: perlite), float (NHL 2, 1:3), finish (lime putty: marble dust 1:2) — limewashed in warm off-white, cream, ochre, or soft terracotta. Visually continuous with the lime-rendered walls and thatched roof of the DD&SA home. Hygroscopic, self-healing, repairable by any trained citizen.

Variant D — Japanese Timber-Adjacent Minimalism

Fine-textured clay-earth plaster (tsuchikabe tradition) using locally sourced subsoil, fine straw or hemp fibre reinforcement, and a burnished surface ranging from pale buff through ochre to warm charcoal. The cultural logic of ma (negative space) and wabi-sabi (imperfection). No decoration — only proportion, material, and presence.

Variant E — Mediterranean Clay-Rendered

Red or buff clay render with the warmth of southern Spain, Portugal, and Italy. Whitewashed lime above the chimney breast. Decorative ceramic tile panels (Azulejos, Majolica, or locally made equivalent) set into the render. Appropriate for southern England, Wales, and coastal communities.

Variant F — Indigenous & Local-Material Interpretations

Any DD&SA community may develop a Hearth Block expression drawing on its specific local geology, craft tradition, and cultural heritage. Qualifying examples from British Isles traditions: Cornish granite-block facing; Welsh slate-clad chimney breast; Orkney flagstone plinth; Yorkshire gritstone facing; Irish hand-made red brick with vernacular arch details; Scottish recycled-whin-dyke-stone outer facing.

VOLUME VII

Construction Manual

Chapter 10 – Before You Begin

10.1 Pre-Construction Assessment Checklist

Assessment	Requirement & Action
Floor loading	Minimum 500 kg/m ² bearing capacity directly below heater. S3+ (>900 kg) requires reinforced concrete pad or transfer beam. Consult structural drawings before proceeding.
Chimney routing	Plan full route from heater to above ridge before construction begins. Identify all ceiling joists, rafters, and purlins. Confirm 300mm clearance to all timber. Mark with string line before breaking any hole.
Thermal break	Mark boundary on floor. Minimum 50mm perlite board or vermiculite screed (1:8 cement: vermiculite) continuously beneath entire heater footprint.
Combustible clearances	Survey 600mm radius around planned heater. All timber, lath, or organic material within this radius must be replaced with mineral materials before construction commences.
Air supply	Confirm minimum 100cm ² free area of air supply to firebox space. Sealed buildings require a dedicated air-supply duct to the heater base.
Cold-smoke test	If reusing an existing chimney, insert a smoke pellet at the base and confirm all smoke exits cleanly at the cap. Repair any leaks before proceeding.
Solar orientation (Trombe)	If a Trombe Wall is to be integrated, confirm the south wall face is within 30° of true south and has unobstructed solar access between 9am and 3pm in December.

10.2 Material Testing

Firebrick test:

Strike two firebricks together sharply. A clean, high-pitched ring indicates dense, well-fired brick. Dull thud indicates under-fired or damaged. 24-hour water-absorption test: should absorb less than 12% of dry weight.

Sand test:

Fill a jar one-third with sand, add water, shake, allow one hour to settle. Silt layer exceeding 8% of total settled depth = too silty for structural mortar.

Chapter 11 – Construction Sequence

Written for an S2 Standard Contraflow Hearth Block. Adjust dimensions per the sizing table in Chapter 6 for other classes.

Phase 1 — Foundation & Plinth (Day 1, ≈6 hours)

1. Mark the heater footprint plus 100mm all round on the existing floor.
2. Where the floor is timber: cut and remove floorboards within the marked area. Expose floor joists.
3. Lay 50mm perlite board or pour 50mm vermiculite-cement screed (1:8) within the marked area. Level with a straightedge. No gaps.
4. Lay first course of dense firebrick on thermal break, running bond, using lime:sand mortar 1:2.5. Check level every three courses; tolerance ±3mm. Continue to plinth height 150–200mm. Allow 24 hours before loading.

Phase 2 — Firebox (Days 2–3, ≈12 hours)

5. Lay firebox floor in firebrick, herringbone or running bond, 2–3mm expansion gaps (unfilled), refractory mortar. Must be PERFECTLY LEVEL: ±1mm tolerance.
6. Lay side walls in firebrick, header course, refractory mortar joints under 6mm. At primary air inlet height, leave 100×50mm opening below door sill. At two-thirds height, leave 75×50mm secondary air inlet at the rear of the side wall.
7. Construct segmental arch crown: plywood former (rise: span = 1:5), arch bricks radiating to arch centre, all joints full. Allow 4–6 hours before removing former; do not load arch for 48 hours.
8. Form throat: refractory slab, 10–14% of firebox floor area, forward-biased position on spring line. Dry-fit before mortaring.

Builder Note: The throat is the single most important geometric element. A throat that is too small causes back-pressure and smoke spillage; too large reduces gas velocity and allows cold-air short-circuit. Measure, cut, and dry-fit before committing to mortar.

Phase 3 — Gas-Path (Days 3–4, ≈10 hours)

9. Construct descending channel wall immediately adjacent to firebox (hot-side wall; will reach 400–600°C). Refractory mortar throughout.
10. Construct outer wall of descending channel (cool-side wall; faces room; will reach 150–300°C).
11. Close top of descending channel with refractory slab; form lower transfer space (approximately 150mm high horizontal chamber).
12. Construct ascending channel walls to chimney junction; install clean-out access door (cast iron, minimum 150×100mm). Dry-fit three courses at every corner junction before mortaring to verify cross-section dimensions.

Phase 4 — Outer Mass (Days 4–5)

Outer mass layers (dense clay brick or stone) built around gas-path core using lime mortar NHL 3.5, 1:2.5. Leave access panels at both clean-out positions. Fit cast-iron doors with mineral-fibre gaskets.

Phase 5 — Chimney

Clay liner within masonry outer. Construct mineral-collar assembly at thatch penetration per Chapter 6. Fit spark-arrest plate and chimney cap before considering the build complete. Fit CO alarm within 3 metres of heater.

Phase 6 — Sensor Integration

Edition 2 includes passive-failsafe sensor integration as a build option. All sensors are monitoring tools; none controls the heater (no electronic actuation). All fail safe: if the sensor fails, the heater continues to operate normally.

Sensor	Type, Position & Function
Flue temperature monitor	Thermocouple type K, fitted in chimney liner 300mm above heater body. Indicates: ideal burn range (200–350°C); over-fire warning (>400°C); poor combustion/wet wood (<150°C during burn). Display panel in living space. Cost: approximately £40–80.
CO alarm	Electrochemical sensor, wall-mounted within 3m of heater at 1.0–1.5m height. Mandatory, not optional. Replace every 7 years. Must be tested monthly.
CO₂ indicator (optional)	Passive colour-change indicator at chimney base clean-out access point. Visual confirmation of complete combustion (CO ₂ -dominant exhaust = complete; CO-elevated exhaust = incomplete). No electronics; uses a chemically reactive paper strip changed annually.
Draft optimisation valve (optional)	Bimetallic draft-control disc fitted in chimney breast above the heater body. Automatically restricts chimney draft slightly when flue temperature exceeds 250°C, improving thermal extraction efficiency by 3–8% in windy conditions. Entirely mechanical; no electronics.

Phase 7 — First-Fire Curing Sequence

13. Day 1 (minimum 7 days after construction complete): newspaper and kindling only, 15 minutes maximum. Allow to cool completely.
14. Day 3: 500g dry softwood kindling only, 30 minutes. Allow to cool completely.
15. Day 7: 1.5kg dry hardwood, 45 minutes. Allow to cool completely.
16. Day 14: first normal burn, 3–4 kg dry hardwood. Inspect all joints and surfaces. Repair any cracks >1mm with matching lime mortar.
17. Day 21: full normal operation commences.

The curing sequence is the physical requirement of the materials, not conservative caution. Steam in uncured mortar joints causes explosive cracking if the heater reaches full temperature prematurely. Do not accelerate this sequence under any circumstances.

VOLUME VIII

Builder Training & Guild Architecture

Chapter 12 – The Civic Hearth Builder Guild

The Civic Hearth Builder Guild is a civic commons institution: a community of practice organised around the shared purpose of propagating the Hearth Block and Trombe Wall craft throughout the Civic Commonwealth. It is not a trade union, a licensing body, or a company. Three principles govern: knowledge flows freely; quality is maintained collectively through peer assessment; and community building needs take precedence over individual commercial interest.

12.1 Guild Structure

Level	Title	Criteria & Responsibilities
Entry	Apprentice Builder	Completed Foundation Course (three months). Assists under Journeyman/Master supervision. No independent builds.
Level 2	Journeyman Builder	Two supervised builds (S1–S2) to Master standard. Leads S1–S2 builds independently.
Level 3	Senior Journeyman	Four builds (min. one S3). Leads all S1–S3 builds. Begins teaching and cultural-variant specialisation.
Level 4	Master Builder	Eight builds (min. one S4/S5); peer assessment; five years active Guild participation; demonstrated teaching effectiveness.
Level 5	Guild Keeper	Elected by Masters; one per community (up to 2,000 residents); manages knowledge commons, apprentice intake, and community building schedule.

12.2 Foundation Course Curriculum (Three Months)

Month 1 – Physics, Materials & Combustion Science

- Week 1: Combustion physics; $Q=mc\Delta T$ formula; wood as fuel; moisture content; pyrolysis temperatures; primary and secondary air theory. Practical: moisture meter operation.
- Week 2: Heat transfer modes; thermal mass charge-and-discharge cycles; radiant vs convective heating. Practical: visit and operate an existing Hearth Block; flue temperature reading.
- Week 3: Materials science; firebrick types and testing; refractory mortars; lime mortars; clay plasters. Practical: mortar mixing and sample preparation.
- Week 4: Gas-path physics; Bernoulli principle; stack effect; draft calculation; failure mode 3 (creosote) chemistry. Practical: chimney draft measurement using manometer.

Month 2 – Practical Construction Skills

- Week 5: Bricklaying: bed preparation, joint control, bond patterns, level and plumb. Practical: lay 500 firebricks to ± 3 mm tolerance.
- Week 6: Arch construction: geometry, former making, voussoir cutting, keystone. Practical: construct and dismantle three practice arches.
- Week 7: Gas-path construction of S1 contraflow on practice stand, fully supervised. Every step documented in Builder's Log.
- Week 8: Lime plastering and limewash. Assessment: visual quality and adhesion test. Trombe Wall glazing installation principles introduced.

Month 3 — Supervised Assisted Build & Assessment

The apprentice joins a live Journeyman-led build on an active DD&SA housing project. All phases from site assessment through to curing-fire management. Assessment by Builder's Assessment Rubric: joint quality, arch geometry, channel cross-section accuracy, door/hardware fitting, plaster finish, sensor installation, curing sequence management, and site clean-up.

12.3 Guild Ethics

- No Guild member shall refuse to train a community member who applies in good faith, regardless of background.
- No Guild member shall seek to create exclusive territorial rights over any building region.
- All Guild members shall contribute at least ten days per year to community building projects at no charge to the recipient household.
- All innovations become part of the civic knowledge commons immediately upon documentation. No intellectual property in Guild craft knowledge.

"The hearth is the oldest gift one human community gives another. We build it with our hands, our knowledge, and our care. When we leave a Hearth Block, it will outlast us. Our reputation is its warmth."

VOLUME IX

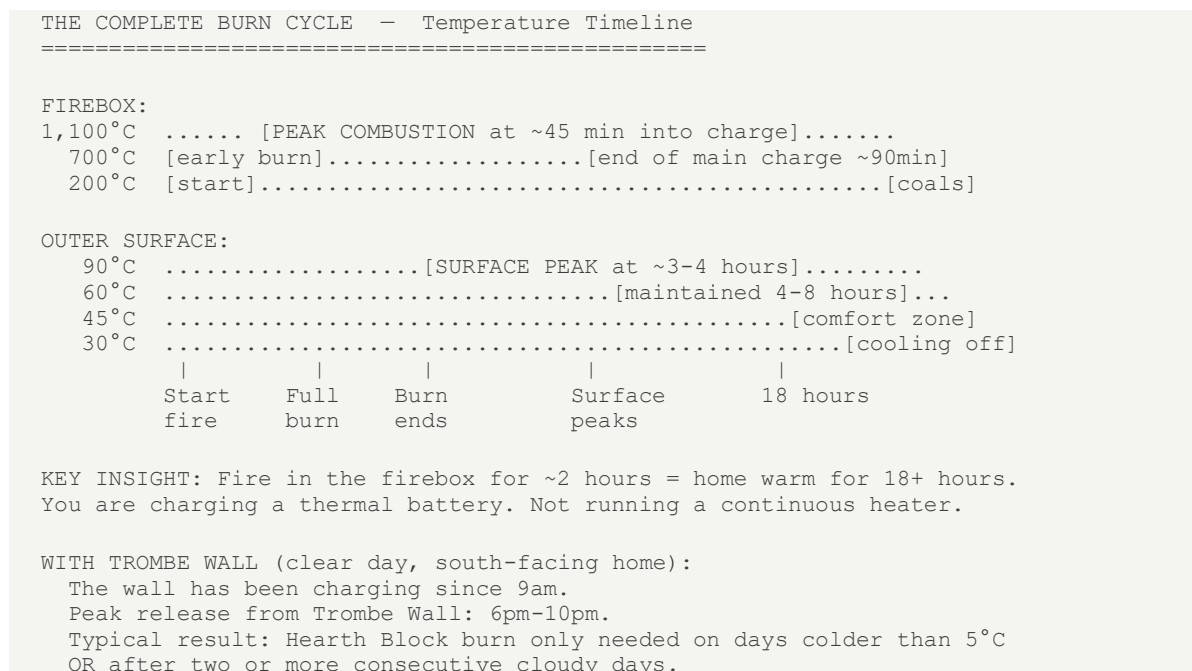
Resident Operation Manual

Chapter 13 — Your Integrated Thermal Home

Your home has two thermal systems. The Trombe Wall works silently, every clear day, charging the building envelope with solar energy and releasing it in the evening without any action from you. The Hearth Block provides your controllable top-up — the fire you light when the day was cloudy, when it is genuinely cold, or when you want the social and sensory experience of a fire.

Understanding the relationship between these two systems is the core of intelligent thermal management of a DD&SA home. The resident who reads their flue thermometer, watches the Trombe Wall vent temperatures, and times their burn cycle to the weather will use significantly less fuel than the resident who fires the Hearth Block by habit rather than by need.

13.1 The Burn Cycle



13.2 Fuel Selection

Species	Seasoning Time & Notes
Ash (<i>Fraxinus excelsior</i>)	12–18 months split. Preferred DD&SA species. Low sap, high energy density.
Oak (<i>Quercus robur/petraea</i>)	24–36 months split. Highest heat content (4,900 kCal/kg) of British Isles hardwoods.
Sweet Chestnut (<i>Castanea sativa</i>)	18–24 months split. Excellent coppice species; spits when burning, load carefully.
Hazel (<i>Corylus avellana</i>)	12 months split. Excellent for kindling and S1-L shoulder-season heater.

Species	Seasoning Time & Notes
Birch (<i>Betula pendula</i>)	12–18 months. Burns bright and hot but quickly. Blend with denser hardwoods.
Softwood (Scots Pine, Larch)	Not recommended for main charge; resin increases creosote. Kindling only.
Pallet / treated timber	NEVER. Chemical treatment produces toxic combustion products without exception.

13.3 The Ten-Step Clean Batch Burn

18. Pre-warm the gas path: hold a lit piece of newspaper near the throat for 30 seconds before loading. This establishes draft and prevents smoke spillage.
19. Clean the ash pit: remove ash accumulation above 50mm. Leave a thin 10–15mm ash bed — this insulates the floor bricks.
20. Lay the kindling structure: natural wax fire-lighter at floor centre; log-cabin of fine dry kindling (10–15mm diameter, 100–150mm high) around it. Air gaps between every piece.
21. Add medium kindling: cross-hatch layer of 25–40mm kindling over the log-cabin. Four to six pieces.
22. Light and observe: light the fire-lighter with door 50mm ajar. Wait for active flame, not smouldering (3–5 minutes).
23. Check flue thermometer (if fitted): during lighting, reading should be rising. If below 80°C after 5 minutes, the gas path is still cold; add one more kindling layer before loading hardwood.
24. Load the main charge: once firebox visibly warm, load 2–4 pieces split hardwood (5–8cm diameter). Parallel to firebox depth; must not block secondary air inlet.
25. Set air controls: close door fully. Primary air fully open; secondary air 75% for first 20 minutes; both reduce to 50% as combustion stabilises.
26. Burn phase: 60–90 minutes vigorous burn. No visible chimney smoke. Clear or lightly browned door glass (heavily black = wet wood or restricted air).
27. Final shutdown: when fire reaches white ash and no active flame, close all air controls fully. Do not reopen the door for 60 minutes.

Flue Thermometer Reading Guide: 150–200°C = wet wood or poor air supply, add secondary air; 200–350°C = ideal range, clean efficient burn; 350–400°C = acceptable; above 400°C = over-fire, reduce primary air immediately; below 120°C after 15 minutes = pre-warm the gas path again before loading a full charge.

13.4 Seasonal Operation

Period / External Temp	Hearth Block Pattern	Trombe Wall Contribution
Cold winter (Nov–Feb, <3°C)	One full burn (8–12 kg) per day, late afternoon.	Provides 15–25% of heating demand on clear days. Reduces burn frequency slightly even in winter.
Shoulder cold (Oct, Mar, 3–10°C)	Every second day, or small burn (4–6 kg) on cold evenings only.	Provides 25–40% of heating demand on clear days. Many days no Hearth Block burn needed.

Period / External Temp	Hearth Block Pattern	Trombe Wall Contribution
Spring / Autumn (Apr, Sep, 10–15°C)	Once or twice weekly at most.	Often provides all heating needed on clear days. Hearth Block for social use or occasional cold evenings.
Summer (May–Aug)	No operation. Annual maintenance period.	Roof overhang prevents overheating. Vents closed during summer — wall cools at night through glazing if operable vents fitted.

13.5 Annual Maintenance

End-of-Season (May)

- Inspect chimney cap for damage, blockage (bird nests), or joint failure.
- Inspect chimney liner at thatch penetration: check mineral collar integrity and spark-arrest mesh.
- Open both clean-out doors; brush out all gas-path channels; inspect for cracking or spalling.
- Inspect firebox arch bricks and door rope gasket; replace gasket if any gap is apparent.
- Inspect outer plaster: hairline cracks (<1mm) leave; 1–3mm fill with matching lime mortar; >3mm consult a Guild Journeyman.
- Inspect Trombe Wall glazing seals; clean glass inner and outer surfaces; check vent flap operation.

Pre-Season (September)

- Cold-smoke test: smoke pellet at firebox base; confirm clean exit at chimney cap.
- Verify CO alarm function; check service life; replace if within 6 months of 7-year expiry.
- Fuel moisture check: all wood stock must be below 20% before use.
- First fire of season: small kindling burn (20 minutes) to re-activate mortar joints and dry out summer dampness.

VOLUME X

The Trombe Wall — Passive Solar Thermal Battery

Chapter 14 — Historical Context & Validation

The Trombe Wall is one of the oldest engineered building systems in the world. Roman architects used dark stone walls behind glazed southerly openings. Puebloan builders optimised south-facing adobe mass walls. Persian and Mesopotamian builders used thick mud-brick walls as thermal buffers. The principle — that a dense, dark, south-facing wall acts as a solar battery, charging by day and discharging heat by night — has been independently discovered and applied across every cold-climate civilisation.

The formal rediscovery and engineering of this principle follows a clear lineage:

- 1881: Edward Sylvester Morse, American engineer, patents the thermal-mass wall device — essentially a slab of dark material placed in front of an existing south-facing window. The patent describes all the operating principles that remain valid today.
- 1964: Félix Trombe (French engineer) and Jacques Michel (French architect) build the first modern full-scale implementation: a house in Odeillo, France, heated entirely by a massive south-facing concrete wall behind single glazing. The name "Trombe Wall" dates from this implementation.
- 1970s: Researchers at Los Alamos National Laboratory, New Mexico, conduct the first systematic thermal-performance studies, validating performance claims and developing design guidelines. The work establishes that the Trombe Wall is not a regional curiosity but a reproducible engineering system.
- 2014 onwards: UK-specific aerogel glazing research (University of Bath and others) confirms that Trombe Wall systems adapted for the British Isles climate (aerogel-filled polycarbonate or high-performance double glazing; south-facing dense stone wall) can save more energy per square metre than external wall insulation — the most commonly applied retrofit measure.

Why Did It Disappear? The Trombe Wall was marginalised in the late 20th century not because it failed, but because: (i) cheap fossil fuel removed the economic incentive for passive solar design; (ii) lightweight timber-frame construction — dominant in post-war British housebuilding — is incompatible with dense masonry walls; and (iii) building-products companies have no commercial interest in selling a system made of local stone and glass. In a DD&SA society, none of these barriers applies.

Chapter 15 — Technical Specification

The DD&SA Standard Trombe Wall is specified as a vented, hybrid thermal storage wall: it provides convective heat transfer during daylight hours via operable vents, and radiant/conductive heat transfer overnight from the charged mass wall. The glazing system uses high-performance double glazing as the minimum specification, with aerogel polycarbonate as the preferred specification where locally producible.

15.1 The DD&SA Standard Trombe Wall — Cross-Section

DD&SA STANDARD TROMBE WALL — Cross-Section (Plan View)

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OUTSIDE (cold, winter)	AIR GAP (hot)	MASS WALL (charging)	LIVING SPACE (warm)
GLAZING		MASS WALL	
(double	50-80mm	300mm stone	
glaz.,	air gap	or concrete	TOP VENT
120mm	40-80°C	Dark surface	<<<<[vent opening]
aerogel		(limewash or	
polcarb		dark plaster)	
option)		charging	
		during day	
		releasing	>>>>[vent opening]
		at night	BOTTOM VENT
		BACKFLOW	
		PREVENTION	
		FLAP at each	
		vent (closes	
		at sunset)	

GLAZING OPTIONS (in order of DD&SA preference):

1. Aerogel polycarbonate panels (locally producible)
2. Triple glazing with low-e coating
3. Double glazing minimum (standard specification)

MASS WALL MATERIAL (in order of DD&SA preference):

1. Dense local limestone or sandstone (300-400mm)
2. Dense fired clay brick (300mm, laid in lime mortar)
3. Cast concrete with aggregate (requires imported cement — lower preference)

15.2 Sizing Guidelines

Parameter	Minimum	Optimal (DD&SA Standard)	Maximum (no overheating)
Wall area (% of floor area served)	8%	12–18%	25%
Wall thickness (stone)	200mm	300mm	450mm
Air gap depth	40mm	60mm	80mm
Vent opening area (top & bottom each)	1.5% of wall area	2.0–3.0%	4.0%
Vent height above floor (bottom vent)	100–150mm	100–150mm	200mm max
Vent height below ceiling (top vent)	50–100mm	50–100mm	150mm max

For a 90m² DD&SA home: optimal Trombe Wall area = 90 × 0.15 = 13.5m². On a south-facing home with a 9m wide south facade, this equates to a 1.5m high Trombe Wall panel spanning the full width of the south elevation — a substantial but architecturally integrated element fitting naturally within the thatched vernacular.

Phase 1 — Foundation (Day 1, ≈4 hours)

28. Mark out the Trombe Wall base line on the external south wall face. The glazing frame outer edge shall be set back minimum 150mm from the line of the thatch edge (eave drip line) to prevent moisture ingress.
29. Excavate a shallow foundation trench 400mm wide × 400mm deep along the Trombe Wall base line (or deeper if ground conditions require — check with a basic load calculation for the wall mass per linear metre).
30. Pour concrete foundation pad (50–80mm above ground level after backfilling). Allow to cure 48 hours before loading.

Phase 2 — Mass Wall Construction (Days 1–2)

31. Lay the mass wall in dense local stone or fired clay brick, lime mortar (NHL 3.5, 1:2.5). Joints under 12mm. Keep wall face flush and vertical.
32. Dark-paint or dark-render the outer face (sun-facing face) using lime plaster with mineral black pigment (iron oxide or natural carbon black). Target: solar absorptivity >0.85. Charcoal-grey or matte black finish.
33. Leave 100×200mm vent openings at bottom (100–150mm above floor level) and top (50–100mm below ceiling level) on the inner face. These will be fitted with backflow-prevention flaps.

Phase 3 — Glazing Frame & Glazing (Day 3)

34. Construct the glazing frame from durable hardwood (oak, sweet chestnut) or recycled metal angle. The frame must be weathertight and hold the glazing panel at 50–60mm from the dark outer wall face.
35. Install the glazing. DD&SA standard: 28mm double-glazed units with low-emissivity coating. Preferred: aerogel polycarbonate panel (80mm thick, U-value approximately 0.5 W/m²K).
36. Install backflow-prevention flaps on all vent openings: simple bimetallic strips or lightweight polymer flaps that open when air in the gap is warmer than room air (during daytime solar gain) and close when the gap cools (at sunset). No electronics, no power.

Phase 4 — Integration with Building (Day 3–4)

37. Seal all joints between the glazing frame and the building fabric with lime mortar or high-temperature silicone sealant. No gap between glazing frame and wall surface.
38. Ensure the internal vent openings are clear and that the vent grilles (if fitted) are open and unobstructed. Test operation of backflow flaps manually before sealing the installation.
39. If a summer shading device is required (for walls without sufficient roof overhang), install external roller blinds or louvred shutters that can be deployed from inside. Mechanical (pull-cord) operation; no electronics.

15.4 Trombe Wall Failure Modes & Mitigation

Failure Mode	Mitigation
Overheating in summer (room becomes uncomfortably warm)	Correct roof overhang sizing (Ch.15.3) is primary prevention. For insufficient overhang: external shading blind or seasonal removal of glazing panel (in aerogel polycarbonate systems, the panel can be temporarily stored).
Backflow at night (wall cools and draws cold air from gap into room)	Backflow-prevention flaps on all vents (mandatory, not optional). Close all vents manually at sunset if flaps fail.
Condensation inside glazing	Occurs in standard double glazing under high humidity + cold conditions. Aerogel polycarbonate eliminates this. If using standard glazing, fit a small vapour-permeable drainage opening at the base of the air gap to allow moisture escape.
Moss or algae growth on dark outer wall face	Apply a lime wash with 5% salt (saline limewash) to the dark outer face annually. This is hygroscopic and mildly biocidal. Also, maintaining the glazing clean improves solar transmittance and dries the surface.
Glazing frame rot (if timber)	Use naturally durable hardwood (oak, sweet chestnut) or metal angle frame. Lime-wash all exposed timber faces annually. Replace within 25–40 years.

VOLUME XI

Environmental Credentials, Carbon Cycle & Governance

Chapter 17 — Wood Burning & the Carbon Cycle

The environmental case for wood burning in a DD&SA context rests on a single, verifiable claim: the carbon released when wood is burned in a managed coppice system is reabsorbed by regrowth within the same coppice cycle. This is biogenic carbon, not fossil carbon. The distinction is not semantic — it is the entire argument.

17.1 Biogenic Carbon vs Fossil Carbon

FOSSIL CARBON (coal, gas, oil):

Carbon locked in geological formations for 50-300 million years
Burning releases carbon that has been out of the atmospheric cycle for geological time. This is NEW carbon entering the atmosphere.
Result: permanent, cumulative increase in atmospheric CO₂.

BIOGENIC CARBON (coppiced wood):

Carbon absorbed from the atmosphere in the last 7-15 years (coppice cycle)
Burning releases carbon that was recently in the atmosphere.
Regrowth reabsorbs the same carbon within the next coppice cycle.
Result: CLOSED LOOP. No net addition to atmospheric CO₂.

THE ACCOUNTING:

1 tonne dry hardwood burned	=	~1.8 tonnes CO ₂ released
Coppice regrowth (7-15 yrs)	=	~1.8 tonnes CO ₂ reabsorbed
Net atmospheric change	=	0 (assuming sustainable management)

THIS IS NOT THEORY. This is basic carbon-cycle science.

It is the same principle that makes beef from grass-fed cattle carbon-neutral under sustainable land management.

17.2 Air Quality — The Real Objection

The legitimate environmental concern about wood burning is not CO₂. It is particulate matter (PM2.5 and PM10), which has documented health effects in high concentrations. This concern is entirely valid for: badly designed stoves; smouldering fires; wet wood; and urban areas with high building density.

The DD&SA Hearth Block addresses this concern through thermodynamics, not regulation:

- Firebox temperatures of 700–1,100°C ensure near-complete combustion of volatiles and particulates at source.
- The non-airtight door design prevents smouldering operation — the most prolific particulate-producing mode.
- Community coppice standards ensure fuel moisture content below 20% at all times.
- One short burn per day versus continuous operation of a metal stove — significantly fewer total operating hours of high-temperature combustion per unit of heat delivered.

Comparative emissions: a correctly operated DD&SA Hearth Block produces approximately 95% fewer PM2.5 emissions per kWh of heat delivered than an open fireplace, and approximately 70% fewer than a conventional thin-wall wood-burning stove operated in low-air (banking) mode. Source: UK Environment Agency comparative assessment of biomass combustion technologies.

17.3 Lifecycle Analysis — Comparison with Heat Pump

Factor	DD&SA Hearth Block	Air-Source Heat Pump
Lifespan	50–200 years	10–15 years before replacement
Embodied carbon in manufacture	Low (firebrick, stone, lime — locally sourced)	High (copper, aluminium, refrigerant, electronics, global supply chain)
Refrigerants	None	HFC refrigerants (high global warming potential; leak risk)
Grid electricity dependency	None	100% (COP of 3 irrelevant if grid uses fossil backup)
Fuel source dependency	Local coppice (community-controlled)	National grid (government and market-controlled)
Failure mode	Mechanical, observable, repairable by Guild member	Electronic, requires specialist; often uneconomic to repair
Resilience during grid failure	Full function	Zero function
End-of-life	Materials reusable (brick, stone, lime)	Refrigerant disposal required; electronics waste

The DD&SA environmental philosophy does not chase efficiency metrics in isolation. It evaluates systems on full-spectrum civic criteria: sovereignty, durability, reparability, local economy, resilience, and ecological impact across the entire lifecycle, not just the operational phase.

The Answer to Critics: "Burning wood only increases atmospheric CO₂ if you release more carbon than the woodland reabsorbs. In a DD&SA system with community coppice forestry, regrowth reabsorbs everything we emit within one coppice cycle. Fossil fuels add new carbon. DD&SA coppiced wood does not. Furthermore, a Hearth Block combined with a Trombe Wall uses 50-70% less wood than a metal stove for equivalent heat output, burning wood at 700-1,100°C with near-zero particulates. This is the cleanest, most sovereign, most resilient heating system available to a DD&SA home."

Chapter 18 — Governance Integration

18.1 Sortition Assembly Responsibilities

- Local Sortition Assemblies: approve community Hearth Block and Trombe Wall building schedules; appoint the Coppice Coordinator; manage the woodyard as a civic common; respond to resident complaints about heater performance or safety; receive annual Guild reports.
- Regional Assemblies: coordinate Guild training programmes; manage shared Master Builder resources; commission updates to this framework when technical advances justify revision; maintain regional material-sourcing maps.
- National Sortition Assembly: constitutional anchoring of the Integrated Thermal Architecture as the DD&SA primary heating standard; manage framework revision through the DD&SA amendment process; maintain civic knowledge commons archive of all build records.

18.2 Risk Catalogue

Risk	Likelihood/Severity	Mitigation
Chimney fire	Low / High	Complete combustion (Law One) eliminates creosote. Annual sweep. CO alarm mandatory.
Thatch ignition	Very low / Critical	450mm radial clearance. Spark-arrest plate. Mineral collar. Physics-calculated envelope.
CO poisoning	Low / Potentially fatal	Annual cold-smoke test. CO alarm mandatory. Non-airtight door prevents sealed-room CO build-up.
Floor overloading	Low / High	Pre-construction floor-loading check. S3+ structural sign-off. No exceptions.
Trombe Wall overheating	Low (correct overhang) / Moderate	Roof overhang sizing per Ch.15.3. External blind if overhang insufficient.
Wet wood / creosote	Moderate / Moderate	Community woodyard moisture testing. Resident training. Fuel standards enforced by community.
Guild knowledge loss	Low / High (long-term)	Physical build records. This framework as civic document. Mandatory Guild training in all new communities.

Chapter 19 – The Twelve High-Value Further Expansions

Reference	Scope
DDSA-ARCH-HEAT-002: Solar + Hearth Block Integration Manual	Full engineering specification for coupling the Hearth Block with evacuated-tube solar thermal panels for domestic hot water. Mechanical control only; no electronics.
DDSA-ARCH-HEAT-003: Cooking Integration	Cook-surface, oven chamber, and water-heating coil integrated into the Hearth Block. One masonry structure: room heating, cooking, and domestic hot water.
DDSA-ARCH-HEAT-004: S5 Communal Hall Manual	Full design and construction manual for the S5 Communal Hearth serving 300–800m ² Civic Assembly halls.
DDSA-ARCH-HEAT-005: Repair & Restoration Manual	Diagnosing, repairing, and restoring existing Hearth Blocks and any surviving pre-DD&SA masonry structures.
DDSA-ARCH-HEAT-006: Prefabricated Core System	Factory or community-workshop prefabricated refractory core; reduces on-site skilled construction time from 4–6 days to 1–2 days.

Reference	Scope
DDSA-ARCH-HEAT-007: Retrofitted Buildings Manual	Installing Hearth Blocks and Trombe Walls in existing pre-DD&SA buildings where structural and solar constraints differ from new builds.
DDSA-ENV-HEAT-001: Carbon Accounting Framework	Rigorous life-cycle carbon model: embodied carbon, operational carbon, avoided emissions, and longevity correction factor for both Hearth Block and Trombe Wall.
DDSA-ARCH-HEAT-008: Material-Sourcing Atlas	Geographically comprehensive atlas of local material sources for every Hearth Block and Trombe Wall material by region across the British Isles.
DDSA-ARCH-HEAT-009: Civic Thermal Mass Floor	Integrating the Hearth Block into a thermal-mass floor system extending the heater's thermal battery into the building fabric itself.
DDSA-ARCH-HEAT-010: Passive House Integration	Engineering specification for combining DD&SA Integrated Thermal Architecture with passive house airtightness and heat-recovery ventilation standards.
DDSA-GUILD-TRAIN-001: Apprentice Practical Workbook	Standalone illustrated workbook for Hearth Block and Trombe Wall apprentices, covering every Foundation Course practical exercise.
DDSA-GUILD-DOC-001: Build Documentation Protocol	Standardised protocol for documenting every build in the civic knowledge commons, enabling national quality tracking and continuous improvement.

Appendix A — Quick Reference Specifications

Specification	S2 Hearth Block	DD&SA Standard Trombe Wall
Total thermal mass (kg)	600–900	Wall: ~450–675 kg/m ² (300mm stone)
Core dimensions	380×450×340mm firebox	300mm wall; 60mm air gap; double or aerogel glazing
Fuel / energy source	5–8 kg dry hardwood per burn	Solar radiation — none required
Thermal discharge period	16–22 hours after burn	8–10 hour lag; continuous in daylight
Chimney ID (mm)	160–200	Not applicable
Clearance to timber (mm)	300 minimum	Not applicable (no combustion)
Clearance to thatch (mm)	450 minimum	Not applicable
Construction time (2 people)	4–6 days	2–3 days
Guild level required	Journeyman (Hearth Block)	Apprentice (with Journeyman supervision)
Lifespan	50–200 years	50–200 years (glazing: 25–40 years)

Appendix B — S2 Hearth Block Material Quantities

Material	Quantity (S2 Contraflow, 900×900mm footprint)
Dense firebrick (230×114×75mm)	380–450 bricks
Refractory mortar (calcium aluminate)	40–50 kg dry weight
Dense clay brick or stone (outer mass)	280–350 units
Natural hydraulic lime (NHL 3.5)	45–60 kg
Washed sharp sand	120–160 kg
Perlite board (thermal break)	0.05 m ³
Lime putty (finish coat)	15–20 kg
Cast iron firebox door + frame	1 unit (min. 240×210mm aperture)

Material	Quantity (S2 Contraflow, 900×900mm footprint)
Cast iron primary air slider	1 unit (100×50mm)
Cast iron secondary air slider	1 unit (75×50mm)
Cast iron clean-out doors	2 units (150×100mm each)
Clay flue liner	Chimney run length + 15% waste
Spark-arrest mesh	0.5 m ² minimum
Mineral fibre collar (thatch penetration)	1 unit, chimney OD + 300mm radial
CO alarm	1 unit (replace every 7 years)
Flue thermometer (optional)	1 unit, Type K thermocouple + display panel

Appendix C – Glossary

Term	Definition
Hearth Block	The DD&SA designation for any masonry thermal-mass heater meeting the Three Laws of Hearth Block Design.
Trombe Wall	A passive solar thermal battery: a dense, dark, south-facing masonry wall behind glazing, charging by day and releasing heat overnight. No fuel, no moving parts, no maintenance beyond glazing cleaning.
Firebox	The sealed combustion chamber where fuel is burned at 700–1,100°C. Lined with refractory materials.
Gas path	The system of channels through which combustion gases travel after leaving the firebox, extracting heat into the thermal mass before exiting through the chimney.
Thermal mass	Dense, heat-retaining materials (firebrick, stone, soapstone, clay) that absorb heat during combustion and release it steadily over 16–24 hours.
Contraflow	Gas-path design where gases descend from the firebox throat before rising to the chimney. High thermal extraction efficiency.
Bell-type	Gas-path design using a chamber where hot gases cool and stratify before exiting at a low port. Self-regulating; suited to communal buildings.
Thermal break	A layer of insulating material (perlite board, vermiculite screed) between the heater base and floor structure.
Mineral safety envelope	The zone of non-combustible material surrounding the heater and chimney, sized by thermal-conductivity calculation to ensure all combustibles remain below 50°C.
Biogenic carbon	Carbon that is part of the current atmospheric cycle, absorbed by plant growth within years to decades and re-released on combustion. Distinct from fossil carbon.
Fossil carbon	Carbon locked in geological formations for millions of years; burning it permanently adds new CO ₂ to the atmosphere.

Term	Definition
Coppice	A woodland managed by regular cutting of shoots from established stools, producing a renewable harvest of small-diameter stems on a 7–15 year rotation.
Thermal lag	The time between peak solar input at the outer face of a Trombe Wall and peak heat release at the inner face. Approximately 8–10 hours for a 300mm stone wall.
Guild	The Civic Hearth Builder Guild — a civic commons institution of trained builders operating under DD&SA civic ethics.
Clean batch burn	The DD&SA operating standard: short, hot, well-supplied burn producing complete combustion, clean white ash, and no visible chimney smoke.
Secondary air	Air introduced above the main combustion zone to combust volatiles and particulates at 700–1,100°C before they enter the gas path.

"We do not turn time back; we move forward with the wisdom its patterns reveal."

— *Ian R. Graham BA (Hons)*

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