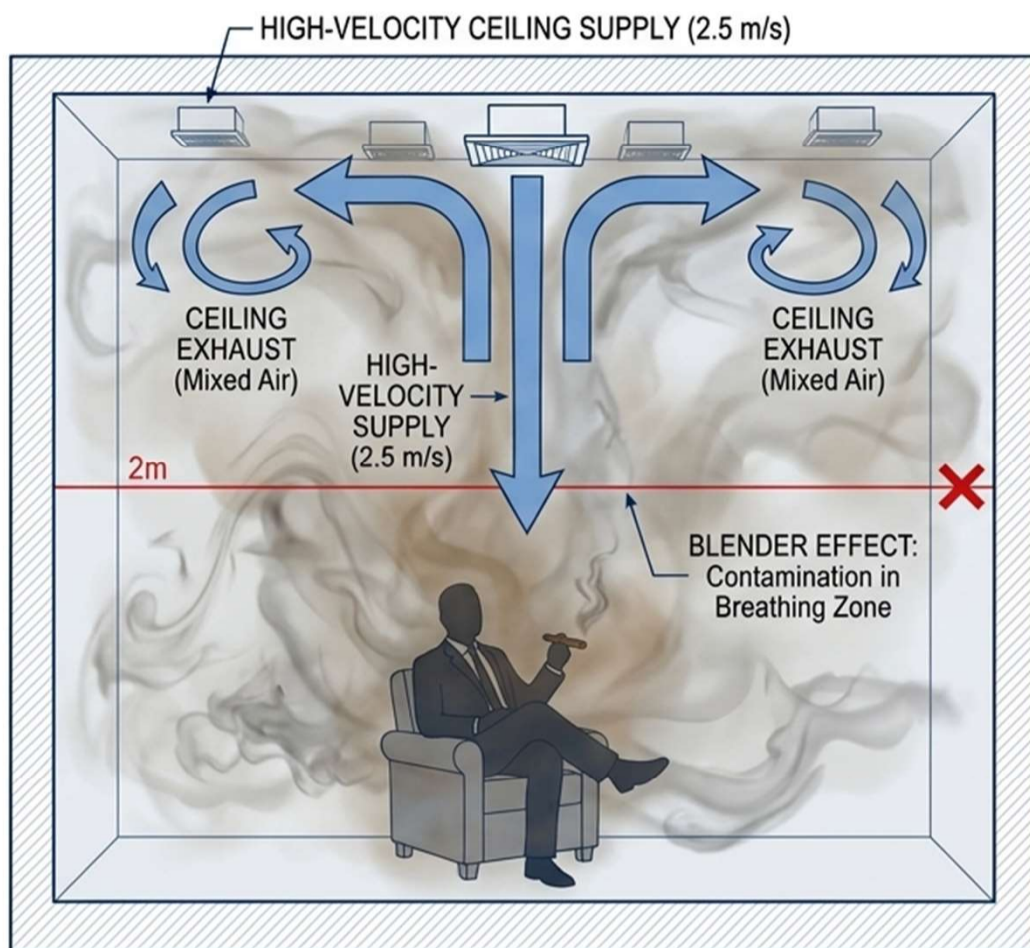


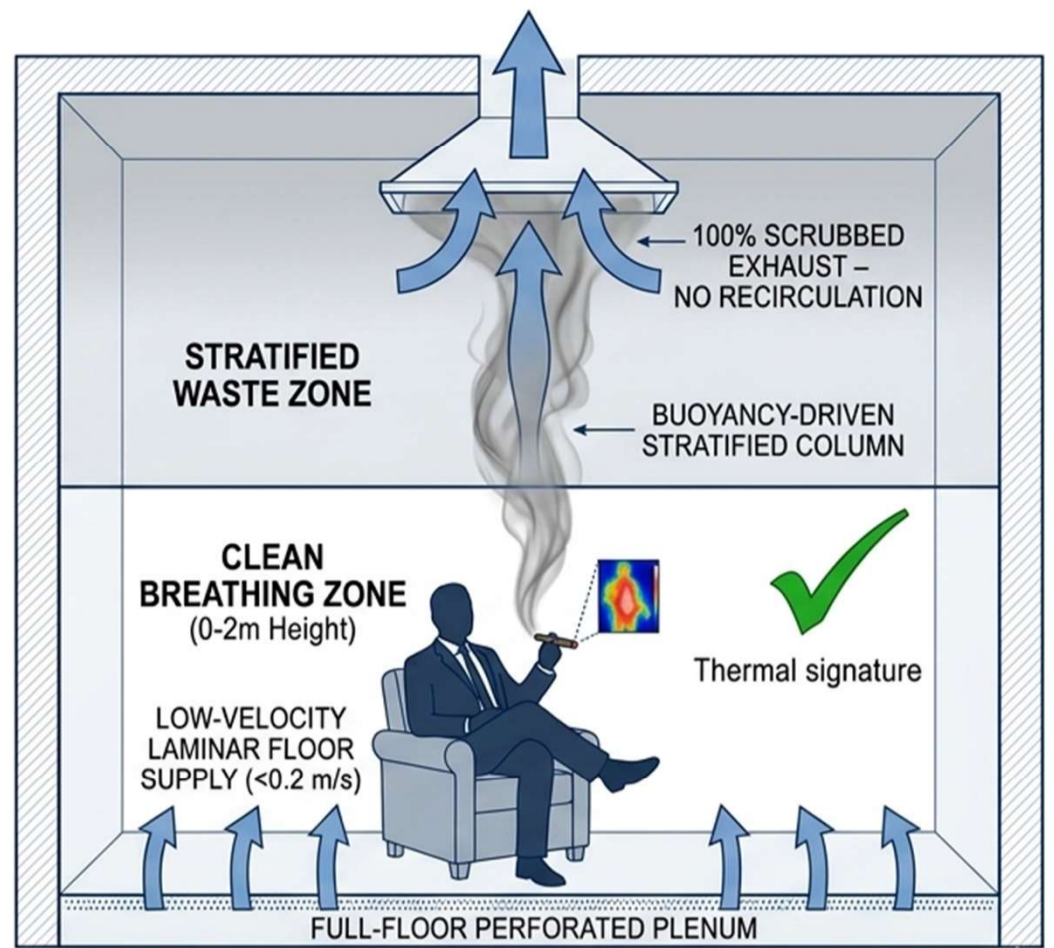


Adapting Zero-Odor, 100% Exhaust Displacement Ventilation for KSA

The Paradigm Shift in Smoke Management



MIXING VENTILATION - FAIL

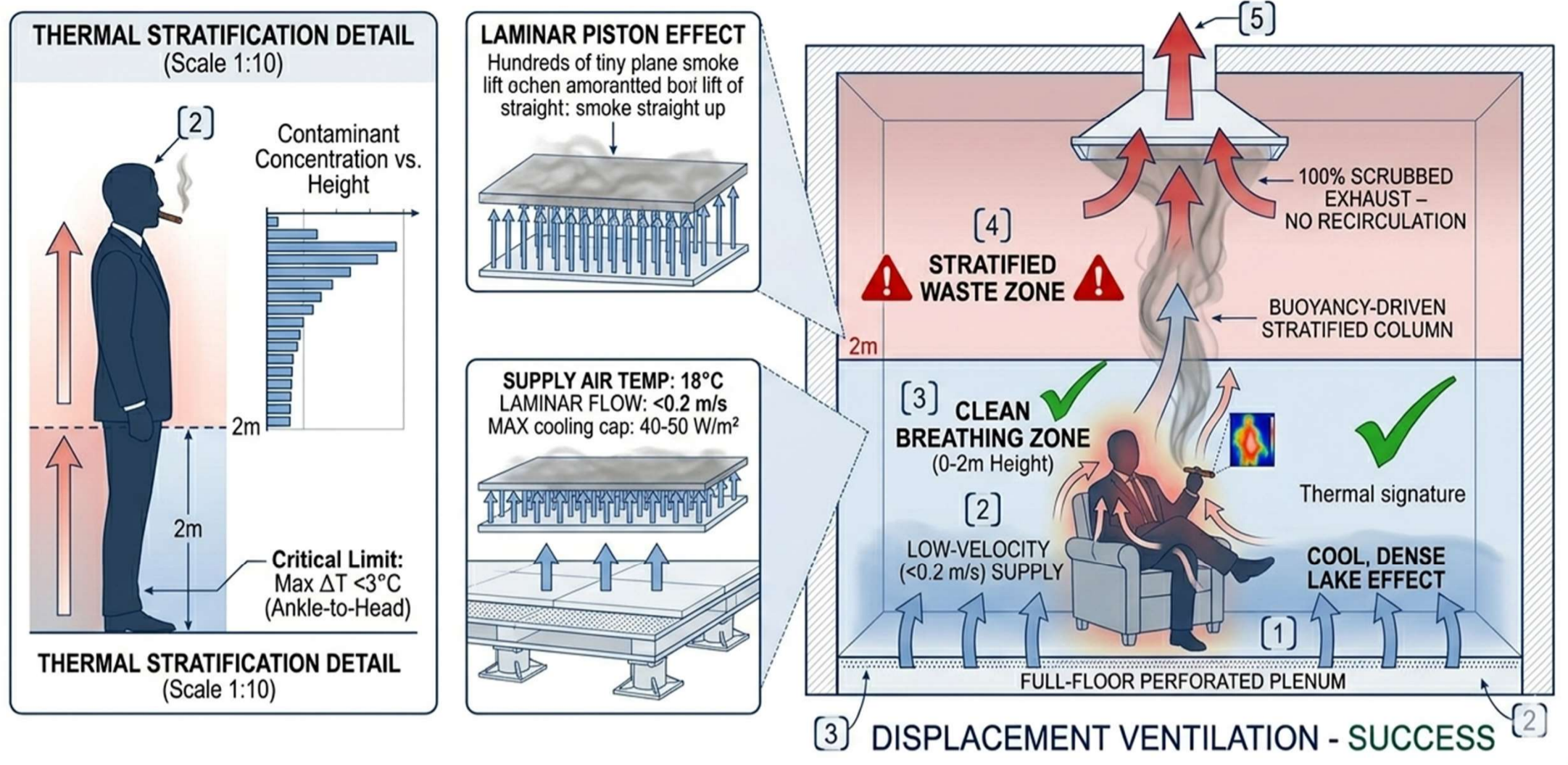


DISPLACEMENT VENTILATION - SUCCESS

- **System Type:** 100% Once-Through, No-Recirculation system.
- **Core Principle:** Buoyancy-driven displacement ventilation (DV). Rely on thermal plumes rather than mechanical mixing.
- **Fluid Dynamics:** Archimedes Number (Ar) at the diffuser face must be significantly >1.0 to ensure buoyancy forces exceed inertial forces, preventing mixing.

"Traditional smoking lounges try to dilute smoke by blowing air at high speeds from the ceiling. This just turns the room into a blender, spreading odor to every surface and into people's breathing zones. We should do the exact opposite. It uses a physics principle called 'Displacement Ventilation.' We treat the smoke like a physical object and simply lift it from the floor to the ceiling in a sealed column, before it ever touches a human face."

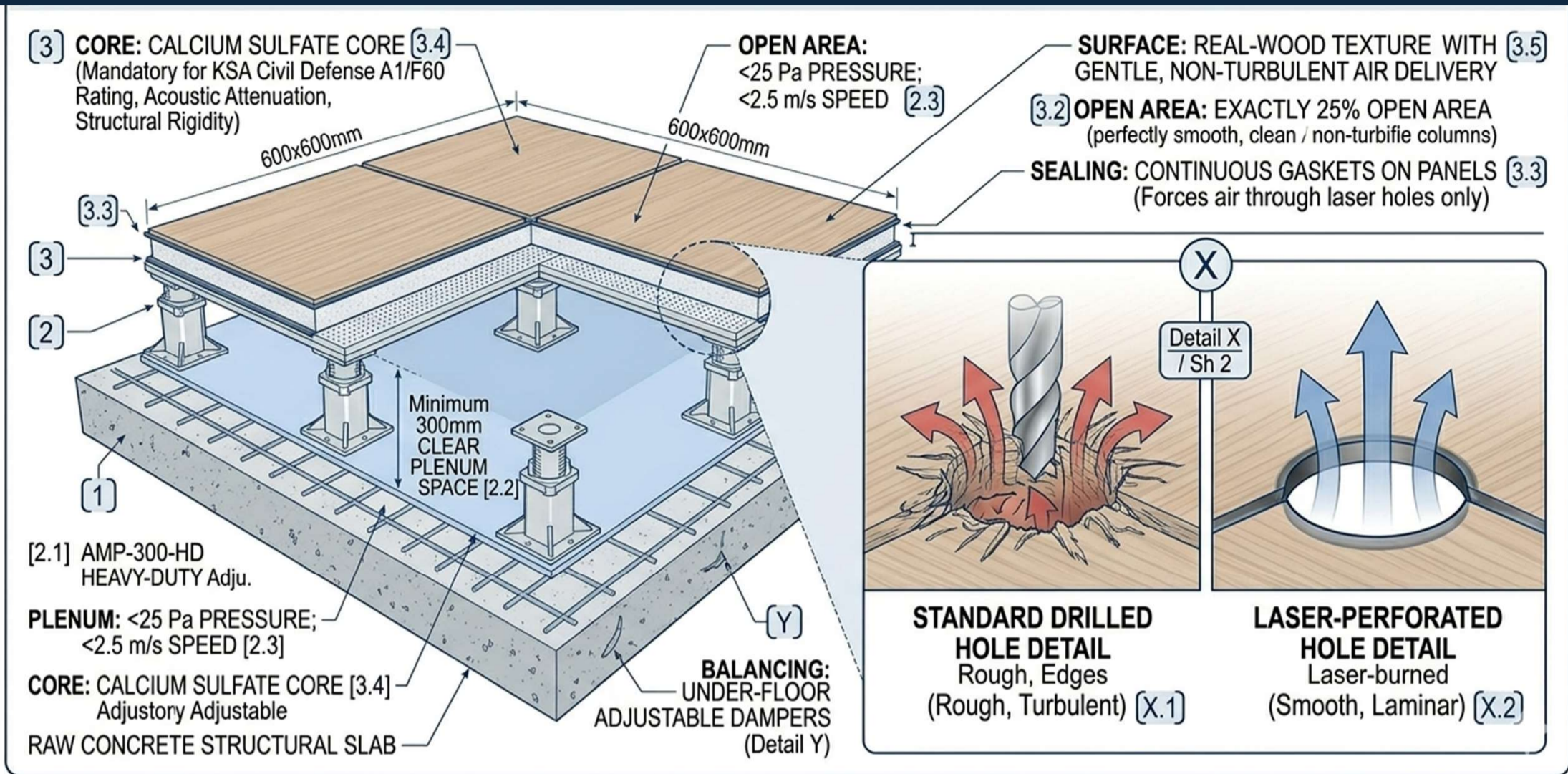
The Core Physics – The "Piston Effect"



- **Supply Velocity:** Strictly $<0.2\text{ m/s}$ (40 fpm) at the floor plane to prevent induction and turbulence.
- **Supply Temp:** 17°C to 20°C (63°F to 68°F). Colder than this causes ankle draft discomfort; warmer than this loses the density required for the "lake" effect.
- **Gradient Limit:** Maximum Ankle-to-Head temperature difference (ΔT) must be $<3^\circ\text{C}$ per ASHRAE standard 55.
- **Critical Limit:** Max cooling capacity of the room cannot exceed 40 to 50 W/m^2 . If solar heat gain through windows exceeds this, the thermal plumes become too violent, destroying the stratification and mixing the smoke.

"We supply air at the floor at 18°C . Because it's cool and dense, it forms an invisible lake across the floor. When a smoker exhales, the heat of the smoke makes it naturally buoyant. The floor air catches this thermal plume and accelerates it upward. The room physically splits in two: the bottom half is clinically clean, and the top half is where all the waste is trapped and extracted."

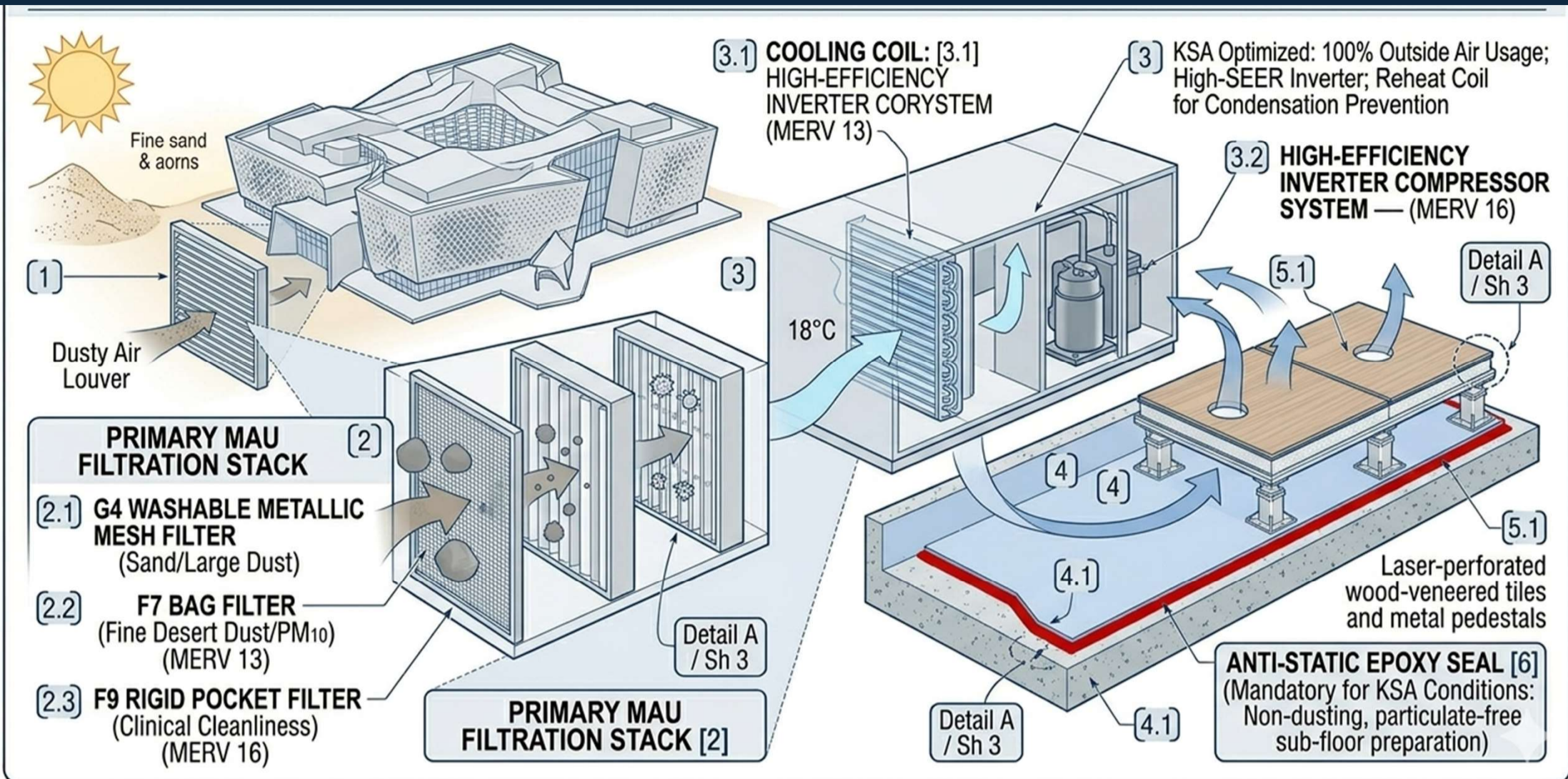
The Secret Weapon – The Laser-Perforated Floor



- **Plenum Height:** Minimum 300mm clear space between structural slab and bottom of tile.
- **Plenum Pressure:** Low positive static pressure: 12.5 Pa to 25 Pa.
- **Plenum Air Speed:** Must be kept below 2.5 m/s to ensure uniform pressure distribution.
- **Tile Specs:**
 - **Core:** Calcium Sulfate (mandatory for acoustic attenuation, structural rigidity for wood veneers, and A1/F60 fire rating for Saudi Civil Defense).
 - **Open Area:** Exactly 25% open area.
 - **Sealing:** Continuous edge gaskets on all panels to force air exclusively through the laser holes.
- **Balancing:** Under-floor adjustable dampers required to balance varying occupant densities.

"You cannot achieve this physics with standard floor vents. We use a raised floor with real wood tiles that have been micro-perforated by lasers. Why lasers? If you drill wood, the backside splinters. Those microscopic splinters create turbulence in the air. A laser burns a perfectly smooth hole, allowing the air to exit in perfectly straight, laminar columns. It acts like thousands of tiny, invisible pistons pushing the air straight up."

KSA Adaptations – Conquering the Desert Climate



- **Supply Filtration (Crucial):**

- G4 Washable metallic mesh (sand/large dust).
- F7 Bag filter (MERV 13) (fine desert dust/PM10).
- F9/E11 Rigid pocket filter (MERV 15/16) (clinical cleanliness).

- **Slab Preparation:** Unsealed concrete releases particulate matter. Sub-floor *must* be sealed with non-dusting, anti-static epoxy coating.

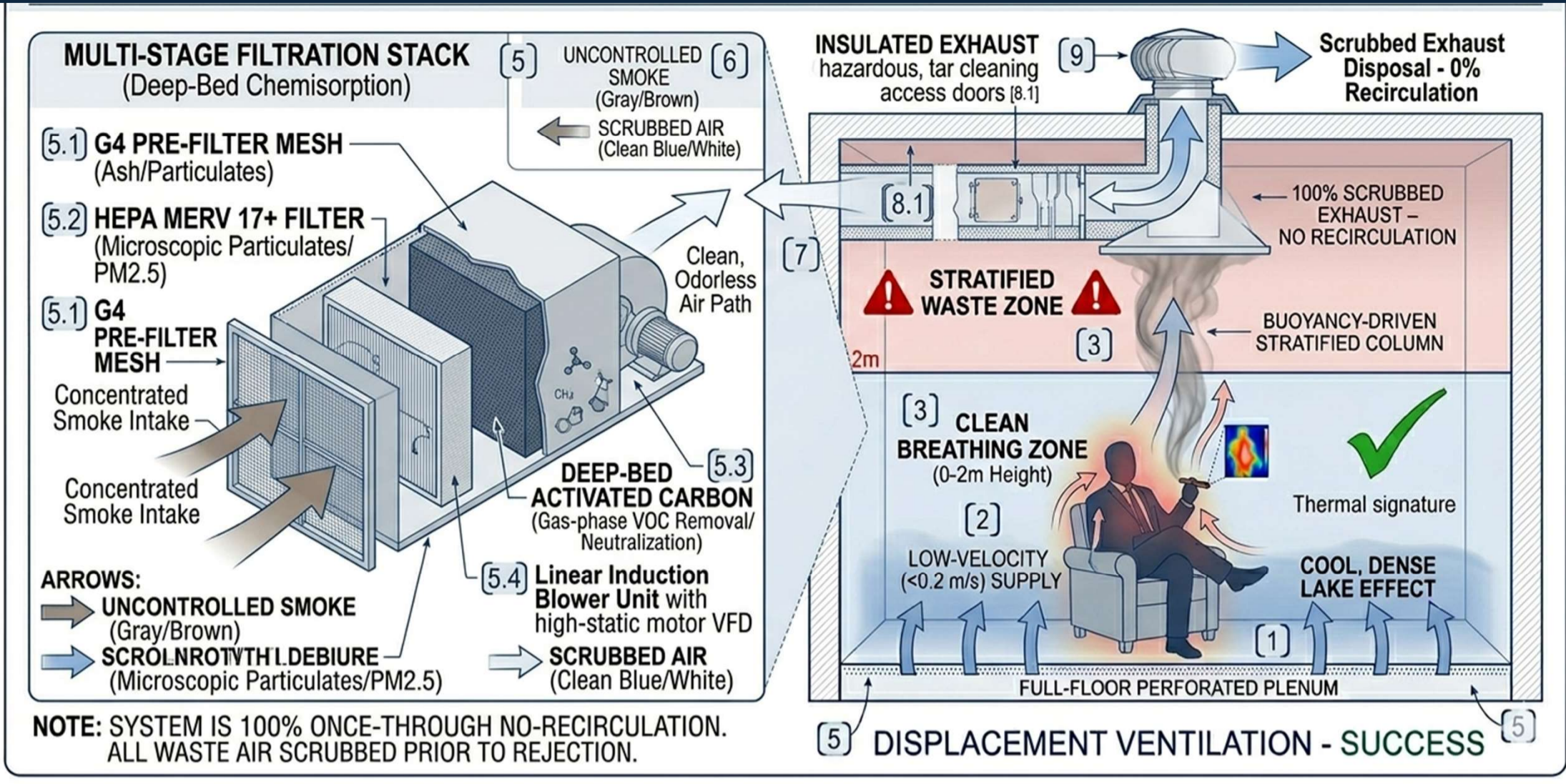
- **Condensation Prevention:** The 18°C supply air hitting a hot KSA concrete slab (if over unconditioned space like a parking garage) will cause massive condensation. Slab must be insulated, or MAU must employ a reheat coil to ensure supply temp is safely above ambient dew point.

- **Plenum Sealing:** All perimeter walls/columns sealed with fire-rated sealant. Leakage must not exceed 10% of total supply volume.

- **Energy Code:** No ERV (Energy Recovery Ventilators) allowed. Tar/VOCs will permanently contaminate the heat exchange wheels. System must rely on high-SEER inverter compressors to meet Saudi Energy Efficiency Center (SCE) requirements despite 100% outside air usage.

"Moving this to KSA introduces two lethal threats to the system: Sand and Heat. If we pull in desert dust, it will coat our floor plenum and blow into the room. Therefore, our Makeup Air Unit uses a 3-stage military-grade filtration system before the air even touches the floor. Secondly, KSA concrete is dusty. Before we build the floor, we must seal the raw concrete with an anti-static epoxy. If we don't, the airflow will turn the sub-floor into a sandstorm."

The Exhaust Paradox – Scrubbing Before Roof Exhaust

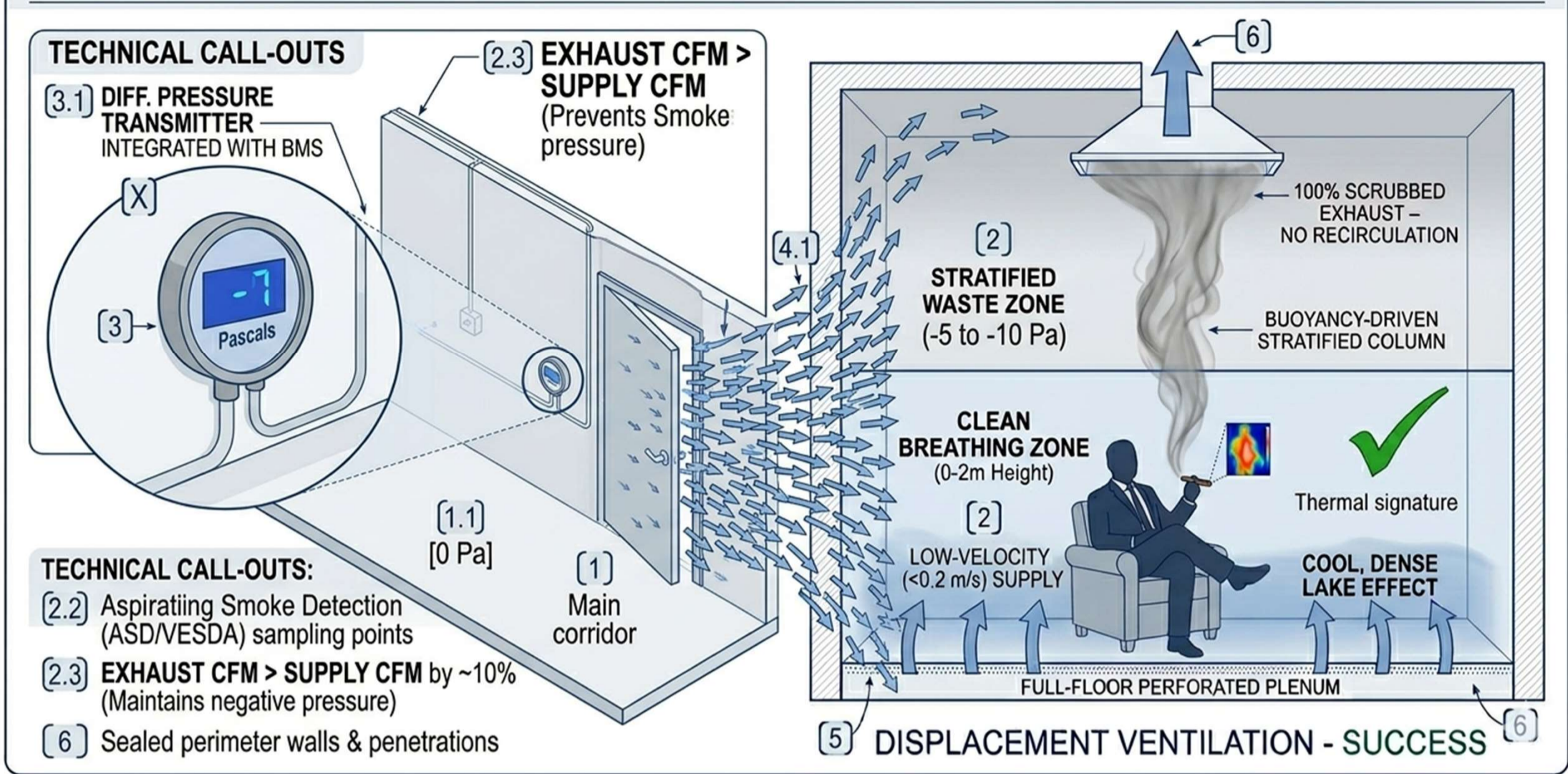


- **Exhaust Filtration Stack:**

- **Stage 1:** G4 Pre-filter (macro-particulates/ash).
- **Stage 2:** HEPA MERV 17+ (microscopic solid particulates/PM2.5).
- **Stage 3:** Deep-bed Activated Carbon / Potassium Permanganate impregnated alumina (Gas-phase chemisorption of VOCs, formaldehyde, benzene).
- **Fan Sizing:** These scrubbing stages create massive static pressure drops. Exhaust fans must be sized with high-static motors and controlled by VFDs.
- **Duct Fire Safety:** Exhaust ductwork classified as "hazardous". Requires access doors for tar cleaning, heavy-duty anti-corrosive epoxy coating inside ducts, and motorized fusible-link fire dampers (70°C/280°C) at slab penetrations per Saudi Civil Defense (SCD).

"We established that we use a 100% no-recirculation system. We throw the air away. However, KSA environmental regulations do not allow us to vent raw, carcinogenic tobacco smoke out of a roof stack into the city atmosphere. So, even though we don't breathe this air again, we must scrub it. We use industrial 'Smoke Eater' units in the ceiling. They pull the concentrated smoke through HEPA filters to catch the tar, and then through activated carbon to neutralize the odor molecules. What comes out of the roof is clean."

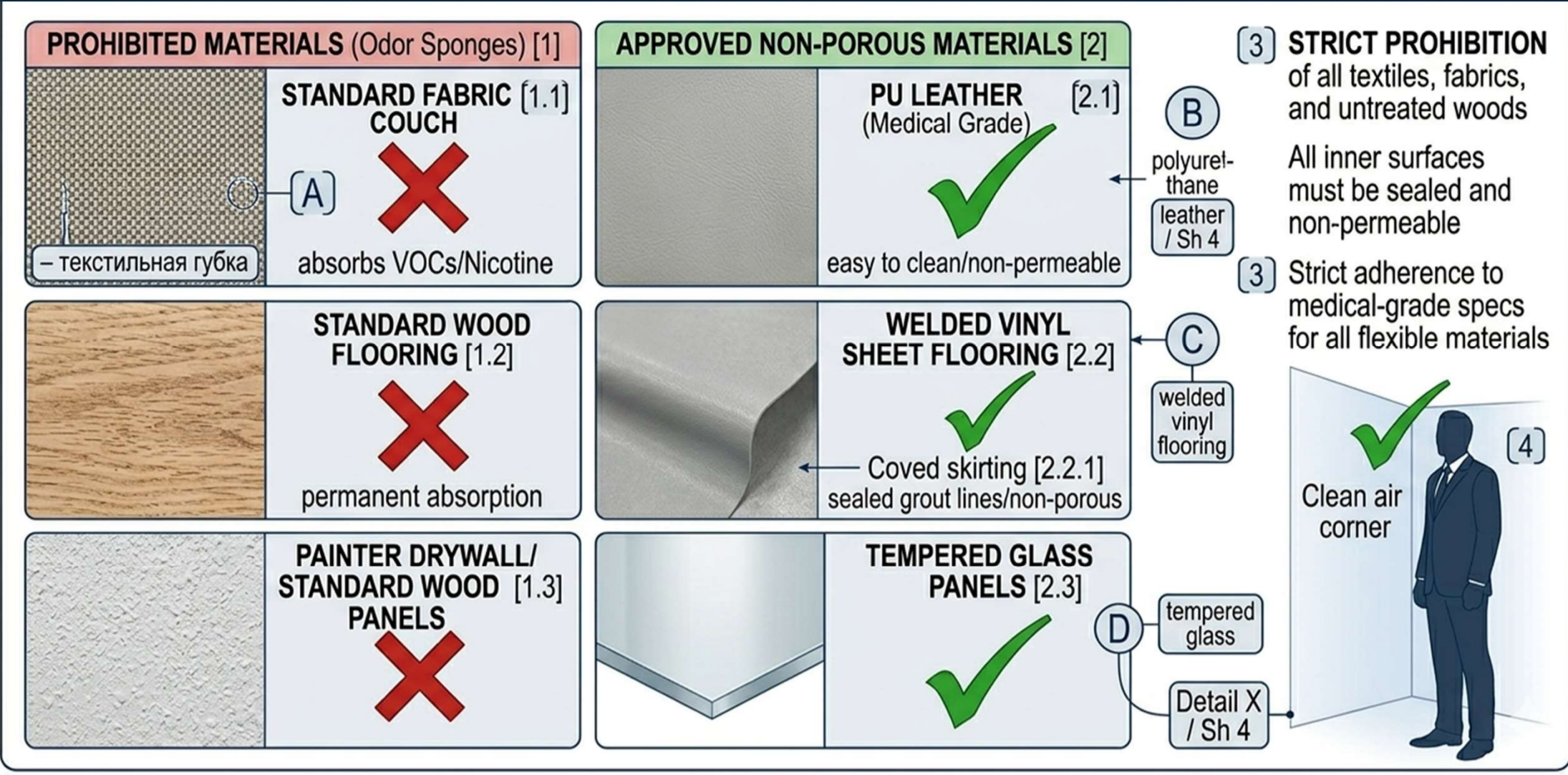
The Airtight Box & Pressure Control



- **Pressure Differential:** -5 to -10 Pascals (relative to adjacent spaces).
- **Control Logic:** Differential pressure transmitter integrated with BMS. Modulates MAU supply and Exhaust VFDs.
- **Air Balance:** Exhaust CFM must exceed Supply CFM by roughly 10% to maintain negative pressurization continuously.
- **Optional Upgrade:** Concealed door-mounted air curtain, synced to door magnetic sensors, to create an invisible air barrier during door cycling.
- **Smoke Detection:** Standard point detectors will clog with tar. Must use Aspirating Smoke Detection (ASD) like VESDA in the ceiling plenum.

"The final piece of the puzzle is the room itself. It must be an airtight box. We maintain the room at a negative pressure of minus 5 to 10 Pascals compared to the hallway. We use a highly sensitive digital pressure sensor. When the door opens to let someone in, the system instantly ramps up the fans to suck air from the hallway into the room. Smoke never escapes into the airport or mall."

Material Science – Zero Odor Reservoirs



- **Walls:** Tempered glass or HPL (High-Pressure Laminate) with sealed edges.
- **Flooring:** Welded vinyl sheet flooring (e.g., Altro) with coved skirting, OR the specified laser-perforated Calcium Sulfate RAF panels with sealed wood veneer.
- **Ceiling:** Continuous sealed aluminum pan system.
- **FF&E:** Stainless steel, powder-coated metals, glass, or high-density sealed polyurethane. Strict prohibition of all textiles, fabrics, and untreated woods.

"All of this engineering is useless if we put a fabric couch inside the room. Fabric, standard wood, and grout lines in tiles act as sponges. They will absorb nicotine and VOCs, and the room will permanently smell like an ashtray within a week. Every single surface in this room must be non-porous. We use tempered glass, sealed high-pressure laminates, welded vinyl floors without grout lines, and medical-grade polyurethane leathers."

Illustration Diagram

HVAC Airflow Diagram - Smoking Lounge

Displacement Ventilation System with Air Purification

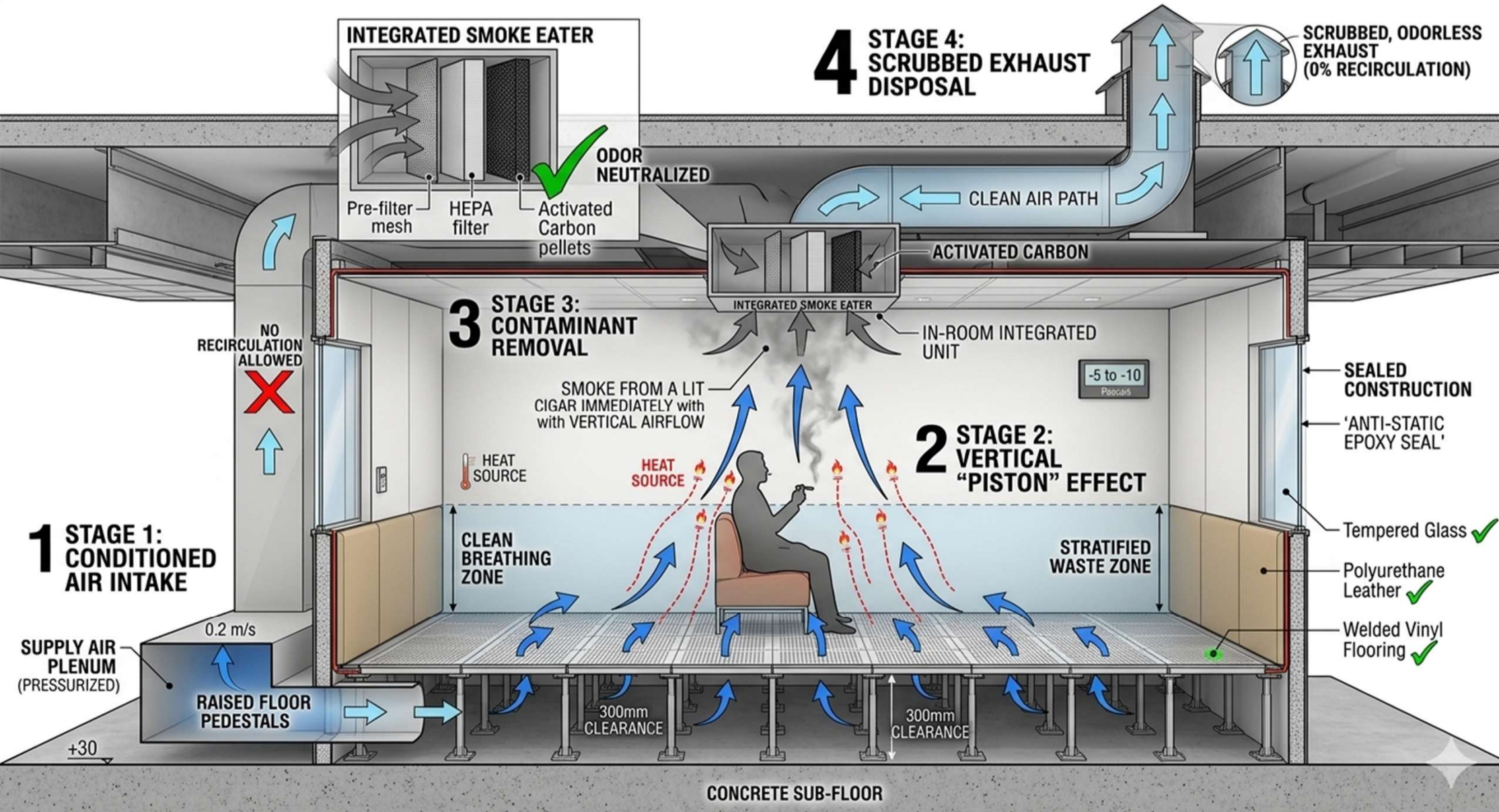
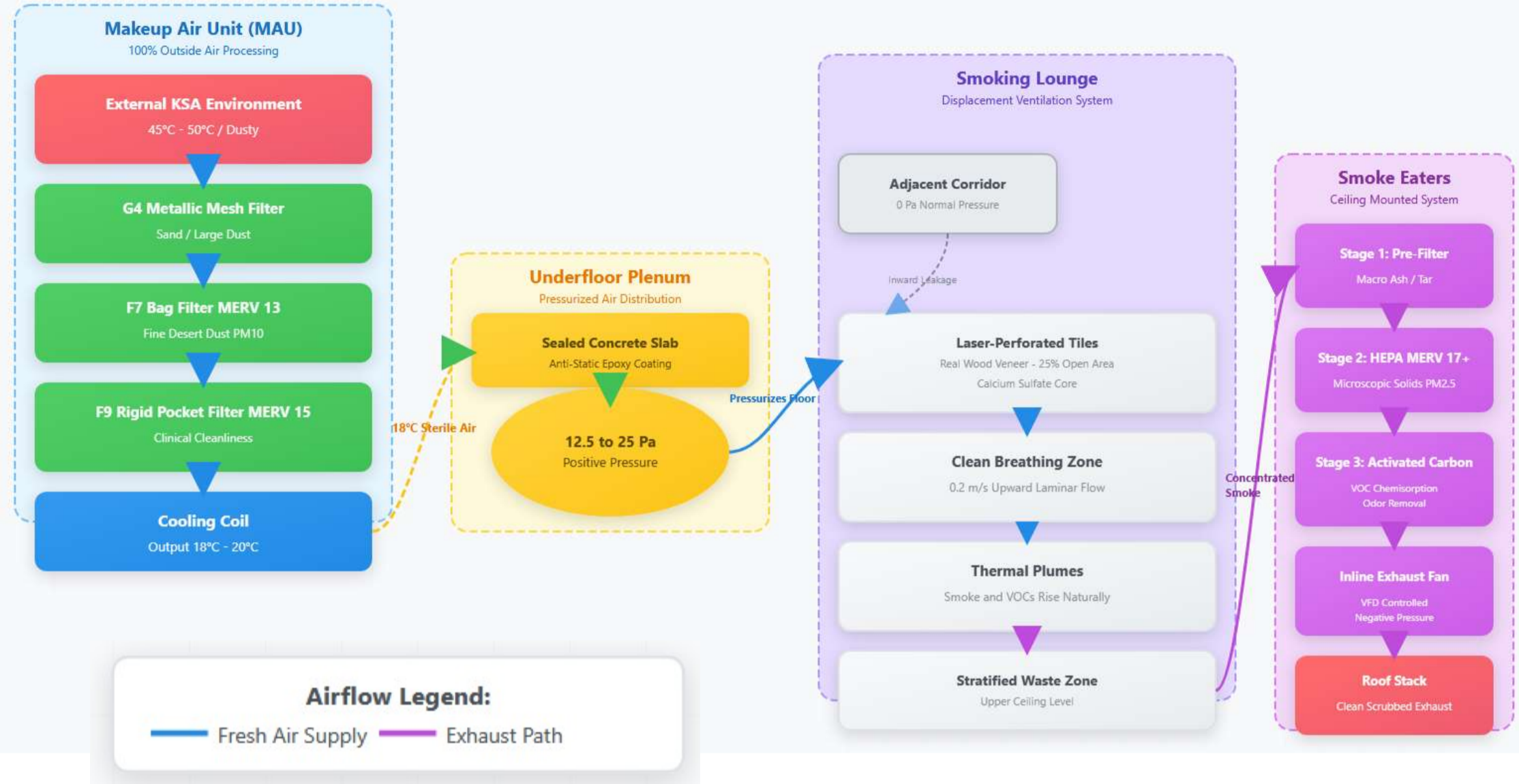


Illustration Diagram



Illustration Diagram

