Low-EMF, Circadian-Aligned Healthy Home

MECHANICAL DESIGN BRIEF - Draft (for discussion)

Version 1.2 – Feb 4, 2026

Executive Summary

This home is being designed for an immunocompromised occupant, with a “hospital-lite” mechanical concept focused on clean air, stable comfort, and careful integration with the architecture rather than maximum energy optimization at any cost. The HVAC brief asks the engineer to treat the primary bedroom area as a protective sanctuary while still delivering good air quality and comfort throughout the rest of the house.

The core goals are:

- Continuous, well-controlled ventilation and filtration (balanced HRV/ERV plus high-efficiency filters, with an option for HEPA-level air to key bedrooms).
- Clear zoning between sanctuary bedrooms and general living areas so air, noise, and contaminants are managed where the immunocompromised person spends the most time.
- Tight humidity control in the 40% range, with explicit attention to the live green wall, indoor tree, and double-height great room so added moisture does not create condensation or mold.
- Quiet, serviceable equipment located in mechanical/garage-adjacent spaces, with smooth metal ductwork, good access for cleaning, and a layout that avoids running noisy or high-load elements through sleeping areas.

1. Overall objectives

- Design HVAC and ventilation for an **immunocompromised** primary occupant, with priority on very clean air, low noise, and stable comfort.
- Target a “hospital-lite” residential standard: high-grade **filtration**, balanced ventilation, tight humidity control, and a protected bedroom “sanctuary” zone.
- Integrate strategy with: double-height great room, live green wall, indoor tree, and high-performance envelope.

2. Zoning and pressure strategy

- Provide at least two conditioning zones:
    - Zone 1: All bedrooms + upper-floor bedroom hall (sanctuary zone).
    - Zone 2: Main living / kitchen / foyer / basement rec + gym.
- Sanctuary zone design:
    - Slightly positive pressure to adjacent areas (airflow from bedrooms → hall; no return grilles in bedrooms).
    - Under-cut doors or transfer grilles sized to maintain proper flow.
- Avoid long shared duct runs between sanctuary and high-load/dirty areas (kitchen, garage, rec, gym) where practical.

3. Filtration and HEPA provisions

- Main AHU(s) to include a proper filter cabinet accepting ≥ 4–5 in deep MERV 13–16 media; select fans and coils for associated pressure drops at continuous low speed.
- Provide a HEPA option dedicated to the sanctuary zone, such as:
    - A HEPA bypass fan-filter unit feeding a dedicated sanctuary supply trunk, or
    - A HEPA filter section serving only the sanctuary branch, not the entire house.
- Ensure mechanical room layout allows physical space and service access for present and future HEPA/filtration upgrades.

4. Ventilation (HRV/ERV) and exhaust

- Provide balanced HRV/ERV delivering continuous, controlled fresh air to bedrooms and main living areas via dedicated ducting (not only through washroom exhaust make-up).
- Design for higher air-change rates in:
    - Sanctuary bedrooms and primary living area.
    - Basement gym and rec room.
- Locate outdoor air intakes on the cleanest façades (away from driveway, garages, neighbour's vents, and pool equipment exhaust).
- Exhaust kitchen and bathrooms effectively while maintaining slight positive pressure in sanctuary zone.

5. Humidity and "live wall" / tree

- Manageble Whole-house humidification/dehumidification to maintain ~40% RH year-round.
- Account explicitly for latent load from:
    - Live green wall and small indoor tree in double-height great room.
    - Any planned higher-planting areas.
- Avoid stagnant humid pockets:
    - Provide supply/return/transfer strategy so air moves gently across the live wall / tree zone and out via a high return or transfer in the double-height volume.
    - Check for condensation risk on nearby glazing/skylights and walls at winter design conditions (dew-point checks).

6. Equipment placement, noise, and ductwork

- Locate air handlers, HRV/ERV, humidifiers/dehumidifiers, and major pumps in mechanical/garage-adjacent areas, not under or directly beside bedrooms.
- Design for low noise, especially in bedrooms and office:
    - Target approx. NC 25 or better in sanctuary spaces.
    - Use low-velocity diffusers and careful register placement (not blowing directly on beds).
- Ductwork:
    - Use smooth, sealed metal ducts; avoid internal fibrous liners in main trunks and near sanctuary zones.
    - Provide access panels/cleanouts on main trunks near AHUs and direction changes to enable duct inspection/cleaning.

7. Controls, modes, and IAQ monitoring

- Provide control modes:
    - “Continuous low” fan mode with verified low noise for ongoing filtration and mixing.
    - “Boost / infection control” mode for elevated filtration and ventilation during high-risk periods.
- Place thermostats for each zone in representative locations (e.g., sanctuary thermostat in bedroom hall, not great room).
- Allow integration of IAQ sensors (CO_2, RH, and optional PM2.5) in:
    - Main living area.
    - Sanctuary zone (bedroom or hall).

8. UV-C and coil hygiene

- Optionally provide UV-C at cooling coil/drain pan:
    - Properly shielded, no light leakage, materials in exposure zone rated for UV.
    - Sized for correct dose at design airflows (supplemental to filtration, not a substitute).
- Use sloped, non-organic drain pans with good access, proper traps, and visible or monitored condensate discharge.

9. Coordination points with architect/electrical

- Confirm bed locations early; keep supplies away from heads of beds and avoid panels or heavy electrical runs on those walls.
- Coordinate bulkhead and duct routes with daylight/skylight design so air distribution does not compromise daylight or architectural intent.
- Route high-current electrical feeders, main panels, EV charger, and elevator power away from sanctuary bedrooms and their main duct runs where feasible.
