FRESH AIR HANDLING UNIT (FAHU)

Materials, Installation, Control Strategies, Testing, and Maintenance.

FRESH AIR HANDLING UNIT

FAHU = Fresh Air Handling Unit

- Purpose: Treats **fresh outside air** before supplying it to AHUs or directly to spaces.
- Common in **commercial buildings, malls, hospitals, hotels** to ensure **indoor air quality (IAQ)** and meet **ASHRAE/Local ventilation codes**.
- **Difference from AHU**: FAHU only handles fresh air, while AHU usually mixes return air with fresh air.
- **Link with Chilled Water System**: Most FAHUs have cooling coils supplied by chilled water to control temperature & humidity.

TYPES OF FAHU

Based on Air Handling Design

1. **Standard FAHU**
   - Supplies treated fresh air only, without return air connection.
   - Cooling coil + filters + fan.
   - Common in commercial buildings.
2. **FAHU with Heat Recovery**
   - Uses **Rotary Heat Wheel**, **Plate Heat Exchanger**, or **Run-around Coil** to recover energy from exhaust air.
   - Reduces cooling load on coils.
   - Required by ASHRAE 90.1 for certain applications.
3. **DOAS (Dedicated Outdoor Air System)**
   - FAHU designed to supply 100% outdoor air to handle **ventilation load only**.
   - Works alongside fan coil units or AHUs that handle sensible cooling.
4. **Packaged FAHU**
   - Integrated DX cooling coil with compressors inside (no chilled water needed).
   - Used where chilled water supply is not available.

Based on Cooling Method

1. **Chilled Water FAHU**
   - Uses building's chilled water system.
   - Most common in UAE.
2. **DX FAHU (Direct Expansion)**
   - Uses refrigerant coils and compressor (like a split AC system).
   - Used in standalone applications or smaller setups.

Based on Installation Location

1. **Indoor Type**
   - Installed inside plant rooms.
   - Requires ducted connection to outside for intake and to supply duct.
2. **Outdoor Type**
   - Weatherproof casing.
   - Installed on rooftops or outdoor pads.

Based on Application

1. **Standard Commercial FAHU** – Offices, malls, hotels.
2. **Hospital/Healthcare FAHU** – With HEPA filters, UV lights, humidifiers, pressure control.
3. **Industrial FAHU** – With chemical filters, activated carbon, explosion-proof motors.

SECTIONS INSIDE A TYPICAL FAHU

From inlet to outlet:

1. **Inlet Section**
   - Weather louver with bird mesh (aluminum or G.I. powder coated)
   - Motorized fresh air damper (with actuator) for control
   - Pre-filter or G4 filter (removes dust/large particles)
2. **Filter Section**
   - **Pre-Filter**: G4/EU4, washable
   - **Fine Filter**: F7–F9, cartridge type
   - **HEPA Filter** (if hospital/cleanroom) — ≥99.97% efficiency
   - Access doors for filter replacement with proper gaskets to avoid bypass air
3. **Heat Recovery Section** *(as per requirement)*
   - **Rotary Heat Wheel** (enthalpy wheel) for energy recovery
   - Sensible-only wheel or enthalpy wheel depending on design
   - Purge sector to prevent cross-contamination
   - Insulated access panel for maintenance
4. **Cooling Coil Section**
   - Chilled water coil (copper tube + aluminum fins, epoxy coated if near sea)
   - Condensate drain pan (SS 304, slope ≥ 1% toward drain)
   - Thermostatic control via 2-way or 3-way motorized control valve
5. **Heating Coil Section** *(as per requirement)*
   - Electric heater or hot water coil (rare in UAE, more in cold climates)
6. **Humidifier Section** *(if required)*
   - Steam grid or spray type for humidity control (common in hospitals/labs)

7. **Fan Section**
    - Centrifugal or plug fan
    - Motor mounted inside or outside air stream
    - VFD-controlled for airflow modulation
    - Fan curve selection must match system external static pressure
8. **Discharge Section**
    - Flexible connections to ductwork
    - Anti-vibration mounts at FAHU base

Materials & Construction Standards

- **Casing**: Double-skin panels, 25–50mm polyurethane or rock wool insulation
- **Panels**: G.I. sheet with powder coating or aluminum
- **Frame**: Extruded aluminum profile with nylon corners
- **Drain Pan**: SS 304 or 316, insulated externally
- **Filters**: As per **EN 779 / ISO 16890**
- **Fans**: AMCA-certified
- **Coils**: AHRI-certified

Reference Standards

- **ASHRAE 62.1** – Ventilation for Acceptable IAQ
- **ASHRAE 90.1** – Energy Standards (heat recovery requirements)
- **DW 143** – Air Handling Units Specification (UK)
- **SMACNA** – Ductwork & air system installation
- **AHRI 430/440** – Coils & fan certification

Site Installation Points

FAHU installed on concrete housekeeping pad **with vibration isolators**

- Sufficient clearance for filter removal, coil pulling, fan maintenance
- Inlet louvers away from exhaust outlets to prevent short-circuiting of air
- Proper sealing of all panels to avoid air leakage
- Flexible duct connection to isolate vibration transfer
- Drain pan slope & proper trap installation for condensate drain
- Heat wheel purge section orientation per manufacturer

FAHU WORKING PRINCIPLE (STEP-BY-STEP AIRFLOW)

1. Air Intake

- Fresh outdoor air enters through **weather louvers** → stops rain, birds, and debris.
- Passes through a **motorized damper** (controlled by BMS or manual setting) to regulate air quantity.

2. Filtration

- **Pre-filter (G4/EU4)** removes large dust particles, protecting downstream components.
- **Fine filter (F7–F9)** removes finer particulates for IAQ compliance.
- **HEPA filter** used in hospitals/cleanrooms for >99.97% filtration of 0.3µm particles.

3. Heat Recovery (if installed)

- If a **heat wheel** or **plate heat exchanger** is present:
  - Exhaust air from the building passes through one side.
  - Fresh air passes through the other side.
  - Sensible or total energy is transferred → reduces cooling/heating load.
- Purge section prevents contaminated exhaust air from mixing with fresh supply.

4. Cooling (and Dehumidification)

- Fresh air passes over **chilled water coil** (or DX coil).
- **Cooling** lowers temperature, **condensation** removes excess moisture.
- Water collected in **SS drain pan** flows to drain trap.

5. Heating (if required)

- In cold climates or special processes, an **electric heater** or **hot water coil** reheats the air after cooling to maintain comfort or process needs.

6. Humidification (optional)

- If air is too dry (common in hospitals, labs), a **humidifier section** adds moisture (steam or spray type).

7. Fan Section

- A centrifugal or plug fan **pulls air through all sections** and pushes it into the ducting system.
- Fan speed may be **fixed** or controlled by a **VFD** to match demand.

8. Discharge to Supply Duct

- Treated, filtered, temperature- and humidity-controlled air is supplied to:
  - **AHUs** (which mix it with return air before distribution)
  - Or directly into occupied spaces if designed as a DOAS system.

In **short**, the FAHU's working principle is:
"Pull in outdoor air → filter → recover energy → cool/heat → control humidity → push into building in controlled quantity & quality."

FAHU CONTROL STRATEGY

Main Objectives of FAHU Controls

- Maintain **indoor air quality** (CO_2 levels, contaminants)
- Maintain **supply air temperature** within design limits
- Avoid **energy wastage** using heat recovery and demand control
- Integrate smoothly with **AHUs / FCUs / DOAS** and the building's HVAC system
- Provide **alarms & protection** for safe operation

Key Control Inputs

FAHU is controlled by a combination of **sensors**:

- **CO_2 sensors** in occupied zones or return ducts → adjust outdoor air quantity
- **Temperature sensors** at coil inlet/outlet and supply air discharge
- **Humidity sensors** (if humidification/dehumidification is used)
- **Differential pressure switches** for filter status
- **Static pressure sensors** in supply duct → for VFD control
- **Limit switches** on access doors for fan safety

Control Components

- **Motorized Fresh Air Damper (MAD)** — modulates to control ventilation air volume
- **Chilled Water Control Valve** (2-way or 3-way) — modulates cooling coil capacity
- **Heat Recovery Wheel Motor/VFD** — varies wheel speed based on temp difference
- **Supply Fan VFD** — adjusts speed to maintain duct static pressure or airflow
- **Humidifier Control** — modulates steam/spray based on RH setpoint

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Typical FAHU Control Sequence of Operation

Step-by-step logic (example for chilled water FAHU with heat wheel):

Startup

1. **BMS sends start command** → supply fan starts via VFD at low speed.
2. Fresh air damper **opens to minimum position** (set by design or code).
3. If **heat wheel present**, starts rotating at preset speed.
4. System checks safety interlocks (filters clean, doors closed, drain pan ok).

Normal Operation

- **Supply Air Temp Control**:
  - Discharge air temperature sensor sends signal to BMS.
  - BMS modulates **chilled water valve** to maintain setpoint (e.g., 18–20°C).

- **Ventilation Demand Control** (if enabled):
  - CO_2 sensor detects ppm level in space/return air.
  - Damper opens more if CO_2 high; closes toward minimum if low occupancy.
- **Heat Wheel Control**:
  - If outdoor air temp close to indoor temp, wheel slows/stops to save power.
  - In hot climate → slows when no meaningful energy recovery possible.

Humidity Control (if present)

- **Dehumidification** happens naturally during cooling (condensation).
- **Humidification** system starts if RH falls below setpoint.

VFD Fan Control

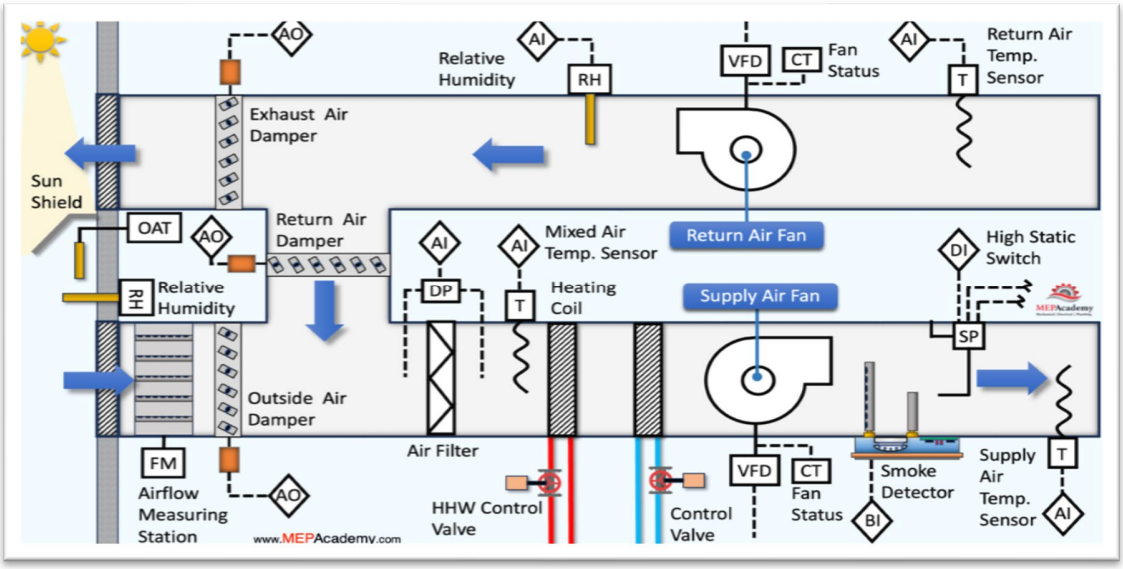
- Maintains **constant duct static pressure** (common in VAV systems).
- Reduces speed during low demand → energy savings.

Alarms & Safeties

- **High filter DP alarm** → triggers maintenance request.
- **Fan overload trip** → shuts unit down.
- **Clogged condensate drain** → trips system to prevent water carryover.
- **Door open interlock** → shuts fan for safety.

Energy Efficiency Features

- **Economizer mode** (in mild climates): Damper opens fully if outdoor air temp/humidity suitable for free cooling.
- **Night purge mode**: Flushes building with outdoor air during unoccupied periods.
- **Heat wheel modulation**: Slows or stops to reduce unnecessary energy use.



TESTING & COMMISSIONING (T&C) PROCEDURE FOR A FAHU

Pre-Commissioning Checks

(Before power-up and starting the FAHU)

Mechanical Checks

- **Location & Installation**
  - FAHU installed as per approved drawings.
  - Housekeeping pad/vibration isolators in place.
  - Proper clearances for maintenance access.
- **Casing & Panels**
  - All panels closed, gaskets intact, no air leakage.
- **Drainage**
  - SS 304 drain pan sloped (≥1%) toward drain outlet.
  - Drain trap installed with correct height to prevent air bypass.
- **Filters**
  - All filters installed, clean, and properly sealed (no bypass gaps).
- **Coils**
  - Cooling coil fins straight, clean, free from damage.
  - Chilled water connections tight, valves functional.
- **Fans**
  - Belt tension correct (if belt-driven), guards in place.
  - Fan wheel rotates freely without rubbing.
- **Dampers**
  - Fresh air dampers/actuators installed, moves freely.

Electrical Checks

- Cable terminations tight and labeled.
- Motor rotation direction confirmed (bump start test).
- Earth continuity check.
- Overload/short-circuit protection set as per motor nameplate.

BMS/Control Checks

- All sensors installed (temperature, humidity, DP switches).
- Actuators connected and responding to BMS commands.
- Chilled water valve operation verified.
- Safety interlocks wired (door switch, drain float switch).

Functional Testing

(Start the FAHU and check operation)

Initial Start

1. Start supply fan at minimum speed via VFD.
2. Check for abnormal noise, vibration, or air leaks.
3. Verify motor current is within rated limits.

Airflow Measurement

- Measure **CFM** at supply duct using anemometer/pitot tube.
- Compare with design airflow (±10% tolerance).
- Adjust VFD speed if needed.

Filter Pressure Drop

- Record initial DP for each filter stage.
- Compare with manufacturer's clean filter values.

Coil Performance

- Measure entering & leaving air temperature (dry bulb & wet bulb).
- Measure entering & leaving chilled water temp.
- Check **ΔT** across coil matches design.

Dampers

- Command damper fully open/close from BMS and verify physically.

Heat Recovery (if installed)

- Check wheel rotation speed and direction.
- Verify purge sector position and operation.
- Measure temp differential across heat wheel.

Performance Verification

- **Supply Air Temperature** at discharge matches setpoint (e.g., 18–20°C).
- **Relative Humidity** within specified range (if humidifier installed).
- **Static Pressure** in duct matches design.
- **Noise & Vibration** within allowable limits.
- **Energy Recovery Efficiency** measured (if required by spec).

4 Safety & Alarm Testing

- Simulate dirty filter → check alarm activation.
- Simulate condensate overflow → unit shuts down.
- Open access door → fan stops.
- Overload protection trips on high motor current.

5 Documentation & Handover

- Record all test results in **T&C report**.
- Submit all documents.
- Get client/consultant sign-off.

Common Mistakes on Site

During Installation

- **Improper drain pan slope** → stagnant water, mold growth.
- **No proper U-trap or wrong trap height** → air bypass, water blowback.
- **Filters installed without proper sealing** → air bypass reduces IAQ.
- **Heat wheel purge sector wrongly positioned** → contaminated exhaust mixing into fresh air.
- **Flexible duct connection missing** → vibration and noise transmitted to duct system.
- **Louvers installed too close to exhaust outlets** → short-circuit of air, smells re-entering system.
- **Coil connections reversed** → reduced cooling efficiency.
- **No access clearance** for coil pull-out or fan maintenance.

During Commissioning

- **Motor rotation not checked** → reverse rotation reduces airflow.
- **VFD parameters not set correctly** → overloading or wrong speed.
- **BMS points mismatched** → dampers/valves not responding to actual commands.
- **Testing done at no-load** → hides coil or heat recovery inefficiencies.

In Operation

- **Filters not replaced on time** → higher fan energy use, coil fouling.
- **Drain traps drying out** → odors entering supply duct.
- **Heat wheel belt loose** → no heat recovery, but motor still running.
- **Chilled water valve stuck** → supply air temperature drifts.
- **Actuators bypassed manually** → constant fresh air, wasting cooling.

FAHU Maintenance Checklist

Monthly

- Check **filter differential pressure**; clean or replace filters if DP exceeds limit.
- Inspect **drain pan and trap** for water stagnation or blockage.
- Listen for abnormal fan noise or vibration.
- Verify **actuator movement** for fresh air damper.
- Check condensate drain line for leaks or clogs.

Quarterly

- Wash pre-filters; replace fine filters if needed.
- Clean cooling coil fins with coil cleaner; straighten bent fins.
- Inspect fan belts (if belt-driven) for wear, tension, and alignment.
- Check all sensors (temp, humidity, DP) for correct readings.
- Lubricate fan bearings (if not sealed type).

Half-Yearly

- Inspect casing and panel seals for leakage.
- Test **BMS control response** (damper modulation, valve modulation, alarms).
- Inspect heat recovery wheel: clean surface, check belt/drive motor, verify purge sector.
- Flush and clean humidifier section (if installed) to prevent scale buildup.

Yearly

- Perform full **airflow measurement** and compare with design CFM.
- Calibrate all sensors and DP switches.
- Inspect motor and VFD for overheating, check electrical connections.
- Repaint or repair any corroded metal parts.
- Replace all gaskets/seals that show wear.

END OF THE NOTES