AET Flexible Space
Under Floor Air Conditioning

UfAC Application

THE SPECIFICATION OF UNDERFLOOR AIR CONDITIONING

UfAC System Concept

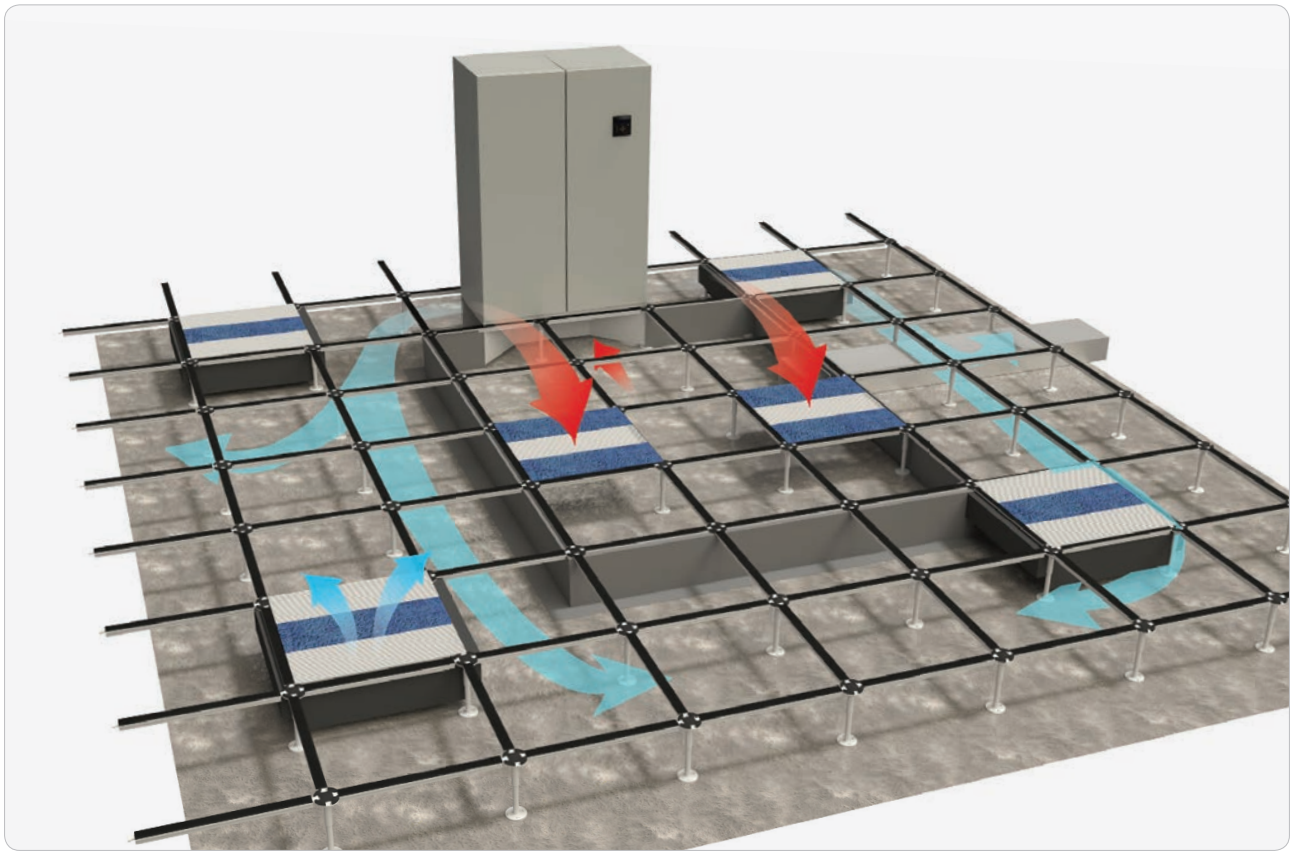
Underfloor air conditioning (UfAC) systems make use of the space beneath a raised access floor to create the air ventilation zone. UfAC systems are inherently flexible, modular in design, and equipment is installed at floor level.

Air is treated by a downflow zone unit (CAM) and delivered into the floor void. The air is then introduced into the room via fan terminal units (Fantiles), and then returned from the space, either via the plenum between the building's slab and the raised floor, or through the space or ceiling void.

This booklet has been written as design application advice for UfAC systems. AET Flexible Space are not liable nor responsible for incorrect interpretation. For detailed product information, refer to the guide "How UfAC Works" and for design advice, contact AET.

Zone equipment used in UfAC systems:

- Variable volume (CAM-V) or constant volume (CAM-C) zone units
- Recessed Fantiles or floor standing Console Terminal Units
- Centralised and/or remote system monitoring and control
- Floor void air baffles and zone barriers
- Optional equipment add-ons and controls



Benefits in application

- Height saving
  – save height in new build construction
  – increase headroom in refurbishment projects
- Energy saving – gain LEED and BREEAM credits for modular zonal design
- Comfort cooling – reduced draughts and personal control
- Flexibility – economical and easy to adapt for tenant fit-out and future change of use
- Sustainability – reduced churn costs and material wastage through system flexibility and modularity
- Enhanced capital allowances – by using the underfloor plenum as the ventilation zone without ducts
- Enhance Displacement Ventilation systems with active fan terminals [Fantiles]
- Easy integration with central plant and other building services
- Healthy workspace – excellent indoor air quality, WELL standard credits

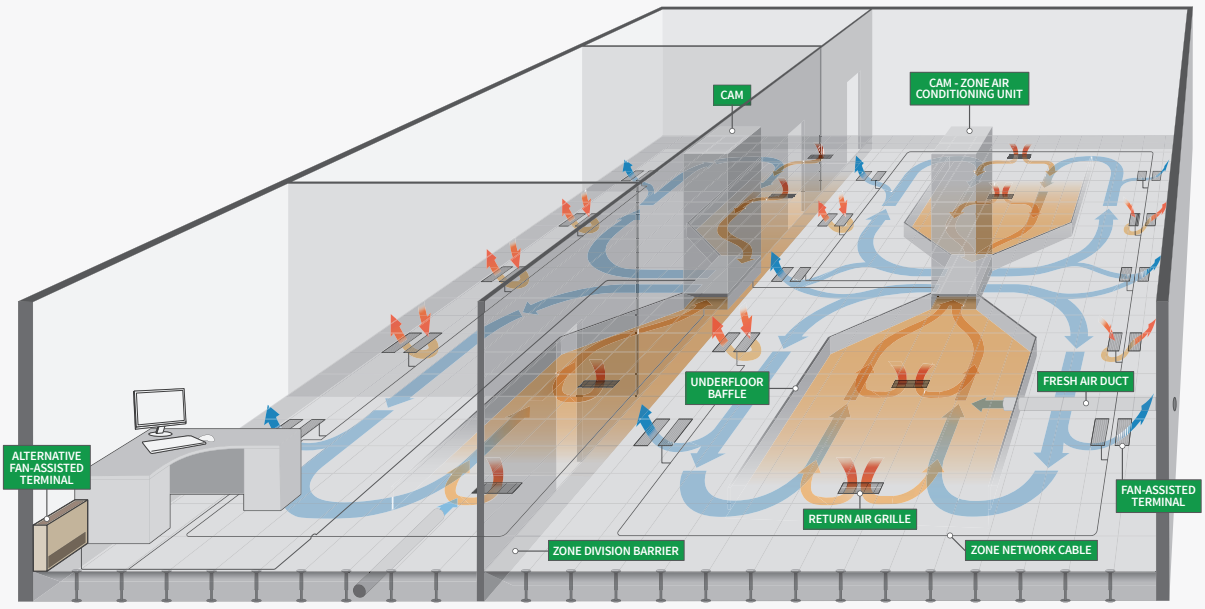
System Configurations

The two different types of downflow / zone unit (Conditioned Air Module / CAM) can be configured with either Chilled Water (CW) or Direct Expansion Coils (DX)

1. CAM-C

FLOOR SUPPLY, FLOOR RETURN AIR

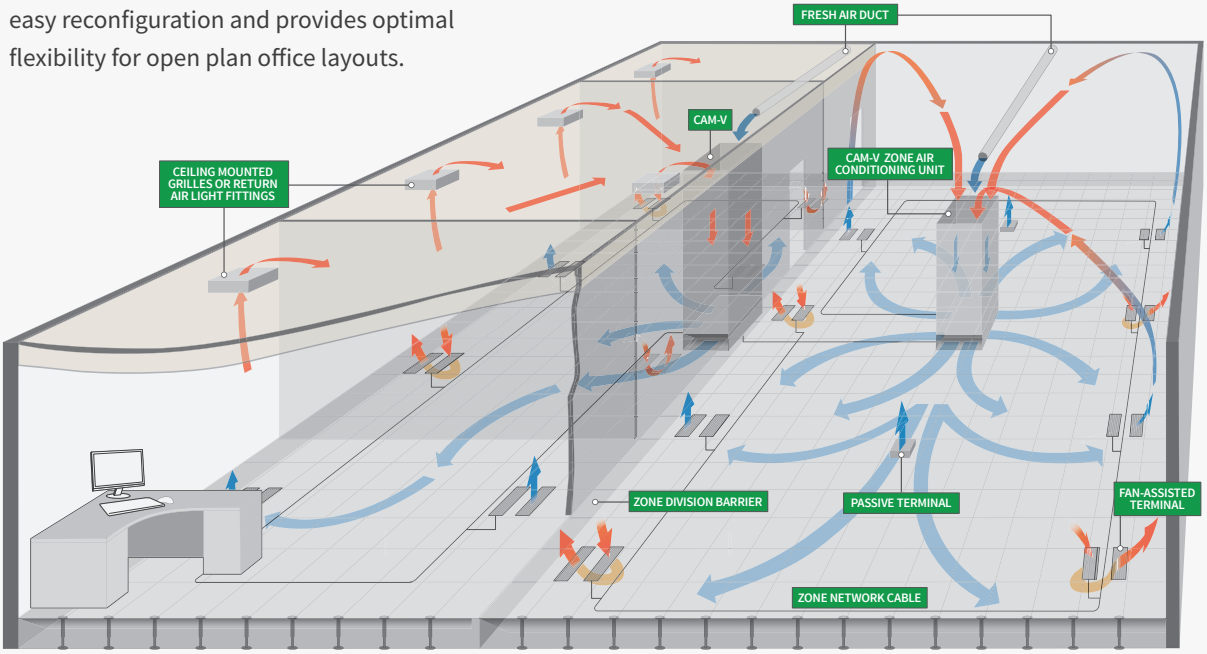
The CAM-C system is the best option for increasing headroom in height restricted buildings and where ceilings may be left exposed to highlight architectural features. It is suited to cellularised and open plan office layouts.



2. CAM-V

UNDERFLOOR SUPPLY AIR, HIGH LEVEL RETURN AIR

The CAM-V system allows complete freedom to maximise the floor plate. No division in the floor plenum permits easy reconfiguration and provides optimal flexibility for open plan office layouts.

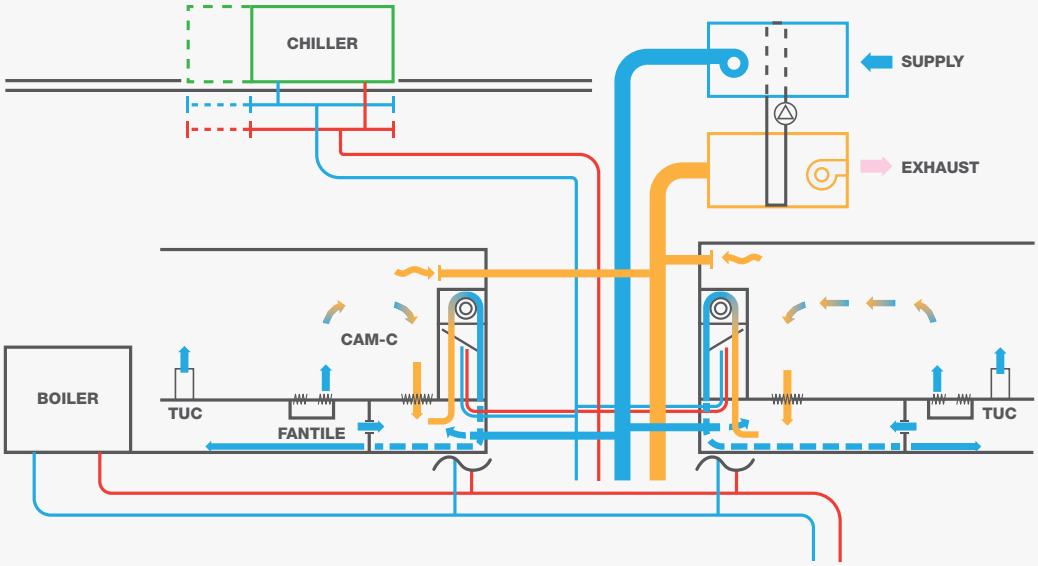


3. Central Plant + Fantiles

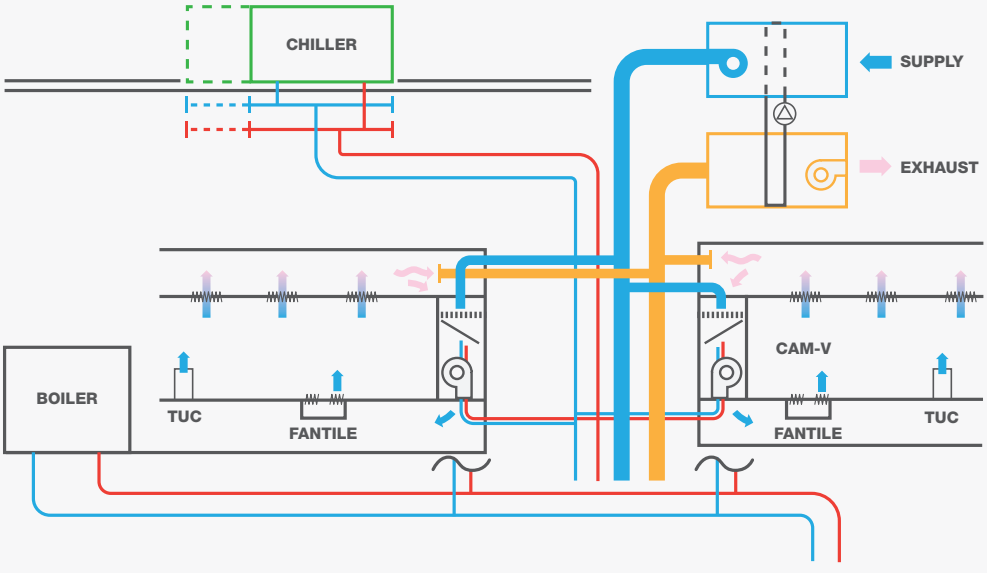
Centralised systems provide displacement ventilation (DV) for larger open plan spaces. Fantiles can be added to displacement ventilation systems to boost airflow and cooling performance, offer personal control and reduce the number of passive grilles required.

Central Boiler, Chiller, DX and Ventilation Plant

CAM-C: CHILLED WATER



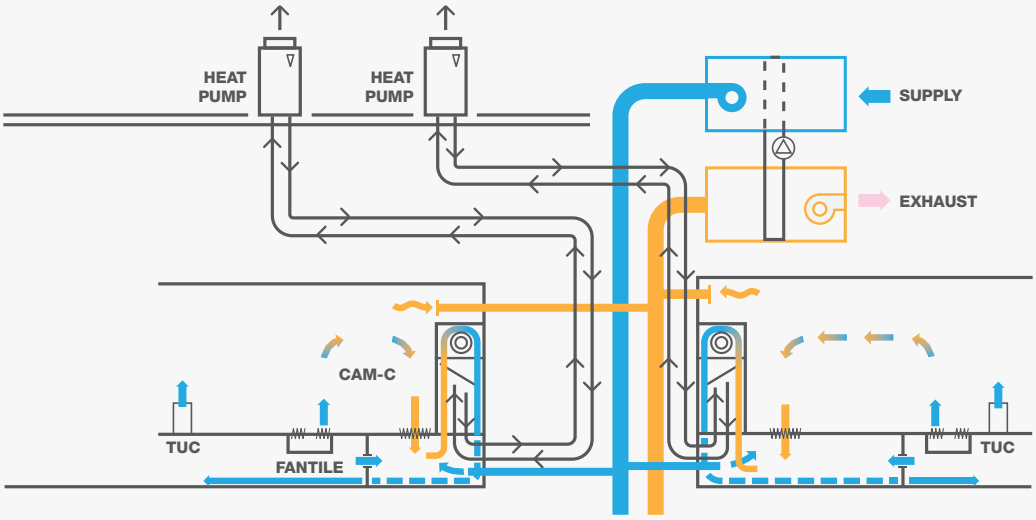
CAM-V: CHILLED WATER



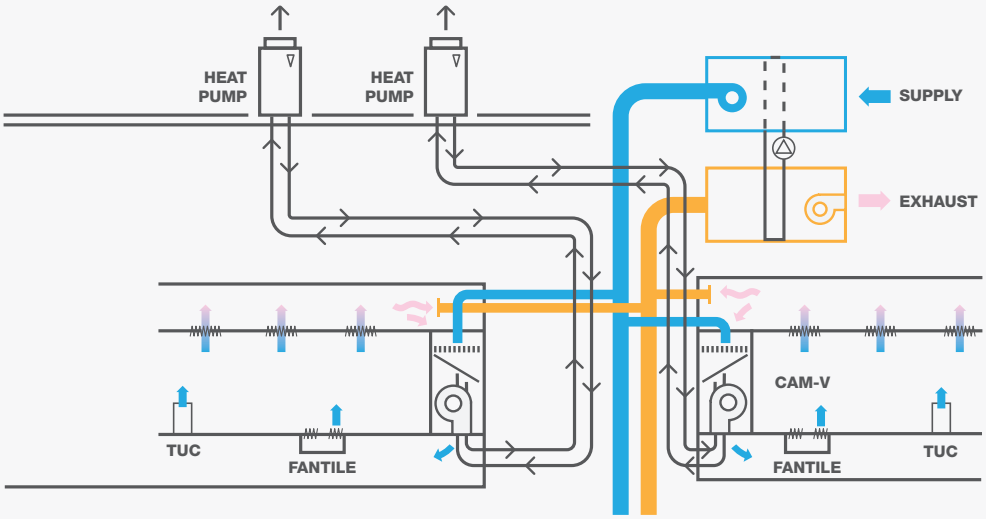
MANY WIDELY AVAILABLE OPTIONS:

- Central plant chillers and boilers
- Central fresh air plant (best for heat recovery)
- Decentralised chilling is usually Direct Expansion but sometimes Absorption
- Decentralised heating is less common with the exception of DX heat pumps
- Decentralised fresh air can be floor by floor or even zone by zone (less cost effective for heat recovery)

CAM-C: DIRECT EXPANSION



CAM-V: DIRECT EXPANSION



System Design

The earlier in the design phase UfAC is adopted, the more benefits can be gained. If known, prepare the following in advance:

- Floor plans and sections
- All known design criteria
- Available floor void and ceiling void dimensions
- Proposed tenancy and letting arrangements
- Access routes for plant movement
- Accreditation aspirations – LEED, BREEAM, WELL Standard etc.

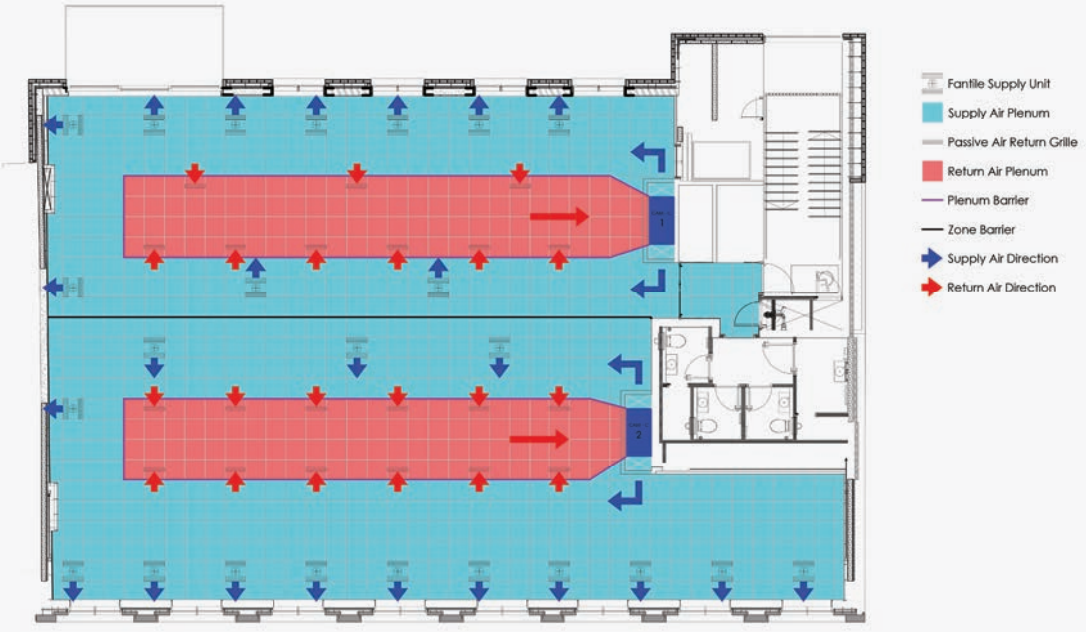
Apply the floor grid to drawings as soon as possible to highlight positioning. Include the raised floor in zone unit cupboards and lift lobbies.

Consider the following:

- Relationship with staircase treads, lift levels and perimeter wall/curtain wall detail. Choose the raised floor set out points
- Zone barriers composed of foil encapsulated mineral wool [Rockwool] can be used as fire barriers
- Consider load bearing of slab and raised floor for the use of the space. Strengthen sub-floor if needed. Seal cracks and seal slab against dust
- Fire rating, noise rating
- Removing existing screed to increase available height in refurbishments
- Design for modularity – consider 600mm floor finishes opposed to sheet floor finishes for ease of access and future flexibility

CAM-C Zone Selection

CENTRAL SUPPLY: UNDERFLOOR SUPPLY AIR, UNDERFLOOR RETURN AIR



Zoning

Correct zoning should fulfil the following requirements:

- Satisfy temperature and humidity conditions wherever possible
- Maintain an adequate renewal of the fresh air
- Maintain constant air circulation within the room
- Be economical and keep maintenance costs low
- Provide stable operation without causing a system imbalance whenever a change in room conditions occurs

CAM-C Zone Selection

PERIMETER SUPPLY: UNDERFLOOR SUPPLY AIR, UNDERFLOOR RETURN AIR

Zoning Rules and Parameters

- Zones are typically 100-300 sq. m. served by a CAM and the required number of Fantiles
- The Fantile spread should match perimeter & internal cooling loads. Position the supply grille nearest to the window
- Fantiles to be a minimum of 2m from the CAM, with the underfloor inlet orientated at a minimum of 90° to the CAM
- Size the zone in accordance with its thermal load. Except for corner rooms, each zone should have only one exposure to assure a homogeneous thermal load
- CAM locations should allow maximum flexibility to allow easy relocation of Fantiles if there is any future change in office layout and interior design
- In multi-tenanted / speculative buildings, the zone should correspond to the minimum rentable area when possible
- No part of the zone should be more than 20m from its CAM to ensure adequate airflow and avoid excessive temperature variations
- When supply air runs exceed 15-20m, each wing's pressure drop should be checked to prevent the reduction of the system performance
- The supply air temperature change across the slab should be calculated. The heat transmission through the slab can be evaluated when the thermal load is estimated. The modification of the supply air temperature due to heat transmission through the raised floor should be applied to the Fantile selection procedure, but it does not affect the thermal balance
- An external static pressure of 20 to 30 Pa is usually sufficient for a typical circuit
- The raised floor net height may limit or modify the air flow characteristics. As a rule, the lower the net height, the shorter the underfloor air route should be
- The depth of the zone should not exceed 5-6 metres from the glazed wall. The inner area is not affected by natural illumination and at peak hours, lighting is expected to be on. From a thermal point of view, this area should be considered as an interior zone and therefore will require removal of heat year round
- Each CAM-C zone should have separate flows of underfloor supply and return air, obtained using underfloor baffles. Each CAM-V system should have underfloor supply and high level return flow, no baffles required

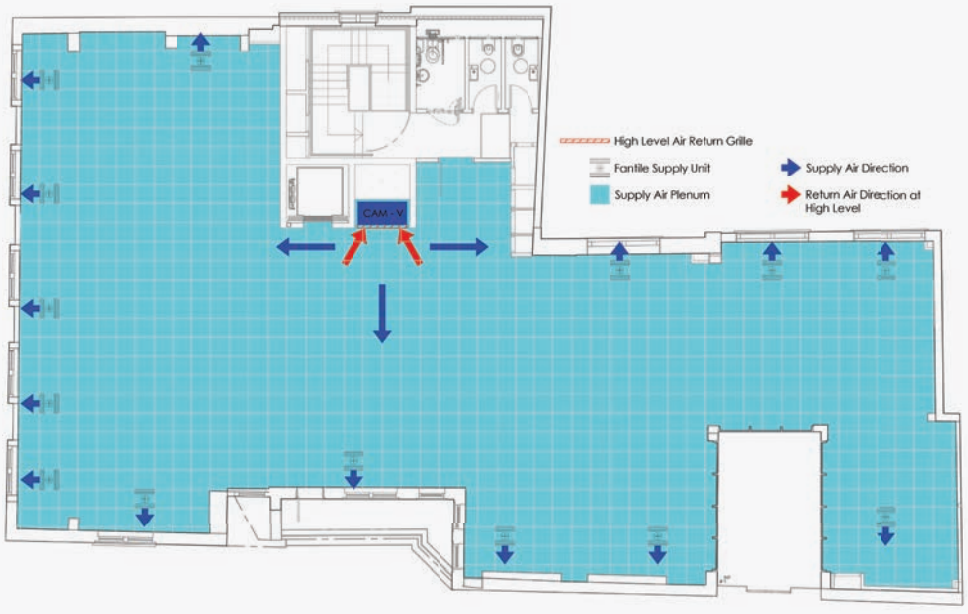
Heating and Cooling Load Calculations

The method of calculating the maximum cooling and heating loads is similar to that used for conventional air conditioning systems except that the influence of the slab must be considered as with UfAC systems, additional load is imposed through heat transmission through the slab when the supply air temperature is higher or lower than that of the space below.

- Select zoning of each floor taking into account the developers tenanting strategy
- Select zones by orientation. If possible – avoid North/South or East/West. East/South, South/West, North/Internal orientation is more acceptable and orientation based zoning provides energy saving when operating during off-peak (load) periods
- Deep space can be designed with separate perimeter and interior zones for greater energy efficiency.
- Consider if fresh air is to be treated centrally, or locally at each CAM, as this will affect the coil selection
- Consider the need for humidity control (water supply and drain to each zone unit)
- Apply zone unit selection details

CAM-V Zone Selection

UNDERFLOOR SUPPLY AIR, HIGH LEVEL RETURN AIR



Zone Unit Selection

Consider the following:

- IsBEM calculations – select packaged VAV solution
- Other energy saving measures (insulation, shading etc.)
- EC or AC fans in CAMs and Fantiles
- Minimum discharge temperature – 13.5°C
- Chilled Water or Direct Expansion coils
- 2-port or 3-port valve (pump energy)
- Hot water, electric or heat pump for heating
- Condensate drain run and fall
- Filtration standard (G4 is standard)
- Minimum/maximum floor void / plenum height
- Baseframe configuration (CAM-C only) – DF, FL, CR, CL etc.

A modular approach to heat load calculations permits easy future modifications

- Consider each type of perimeter module and allow approximately 1m depth into the room with solar, fabric, infiltration, lighting, power and people – normally 120 – 160 W/m^2
- Consider internal areas as 1m^2 modules with infiltration, lighting, small power and people – normally 55 W/m^2

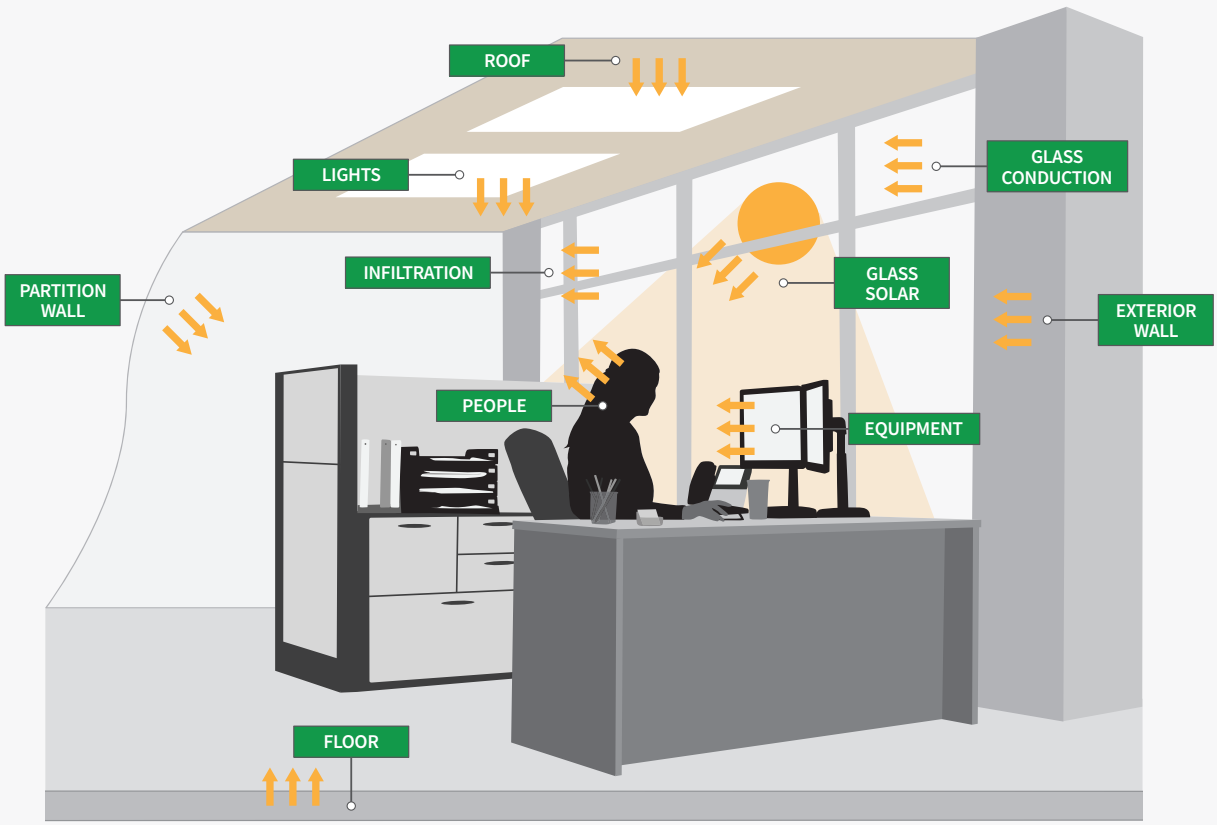
Energy Saving

Office buildings are frequently used for multi-tenant and multi-use purposes, and they may also include retail outlets, restaurants, canteens, banks etc. Each of these areas may operate during different working hours and the use of zoning for each individual area allows for independent operation. Therefore, when a zone does not need air conditioning, the CAM and Fantiles can be shut-down and energy saving achieved accordingly.

Night Cooling

The slab is expected to contribute to the thermal process by storing and releasing heat through a flywheel effect. This can be exploited to obtain effective free cooling. In some buildings this can result in a considerable energy saving and at system start up in the morning the supply air will take advantage of this free-cooling effect.

COOLING LOAD COMPONENTS



Zone Unit Positioning and Enclosures

It is important to consider functionality and aesthetics with respect to the zone unit integration.

CAM-C

CAM-C units may be located centrally or at the perimeter. As airflow is all at underfloor level, the units may be free-standing within the space, or housed within an enclosure. Note that enclosures can have an impact on nett lettable space but can also improve aesthetic design and acoustic levels.

Maximum CAM-C dimensions:
1950mm height x 2000mm width x 750mm depth

CAM-C25 HOUSED IN CUPBOARD ADJACENT TO CENTRAL RISER

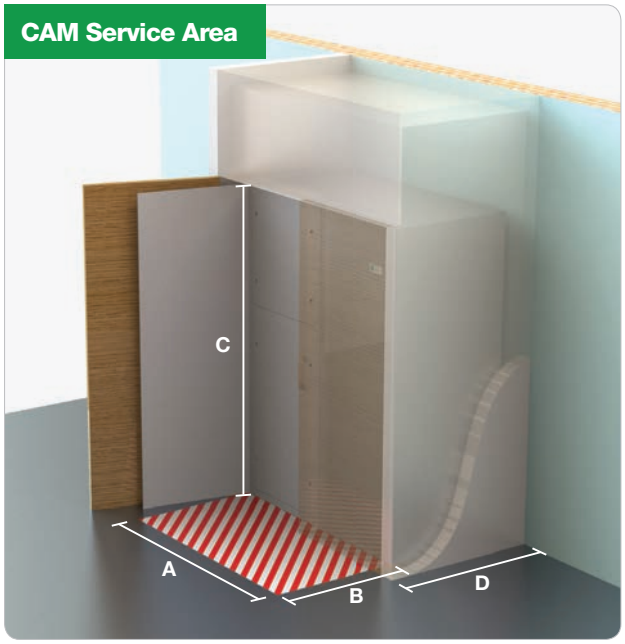
CAM-V

The variable volume CAM-V is normally located centrally, requires a full floor to ceiling enclosure and typically requires additional attenuation. Cross talk attenuators may be needed when space is cellularised. A high level return air grille is typically incorporated into the design, but alternative air paths are possible. Floor void zone barrier is required.

Maximum CAM-V dimensions:
1950mm height x 1450mm width x 750mm depth

CAM-V33 HOUSED IN CUPBOARD WITH ADDITIONAL ATTENUATION

CAM Service Area



	CAM-C15	CAM-C25	CAM-C35
A (mm)	1000	1450	2000
B (mm)	800		
C (mm)	1950		
D with panels (mm)	770		

	CAM-V11	CAM-V22	CAM-V33	CAM-V44
A (mm)	850	1300	1450	1450
B (mm)	800			
C (mm)	1900		1950	
D with panels (mm)	550		750	

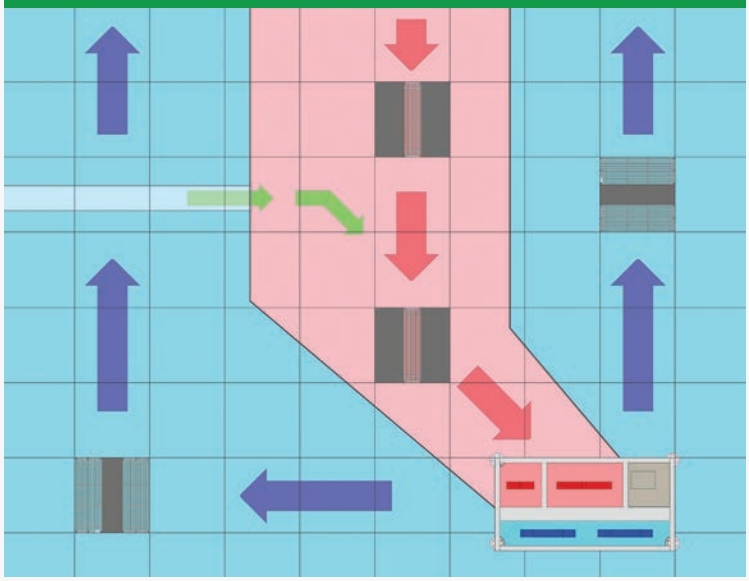
All units must be spaced 50mm away from walls to avoid vibration transfer

Baseframe Configuration

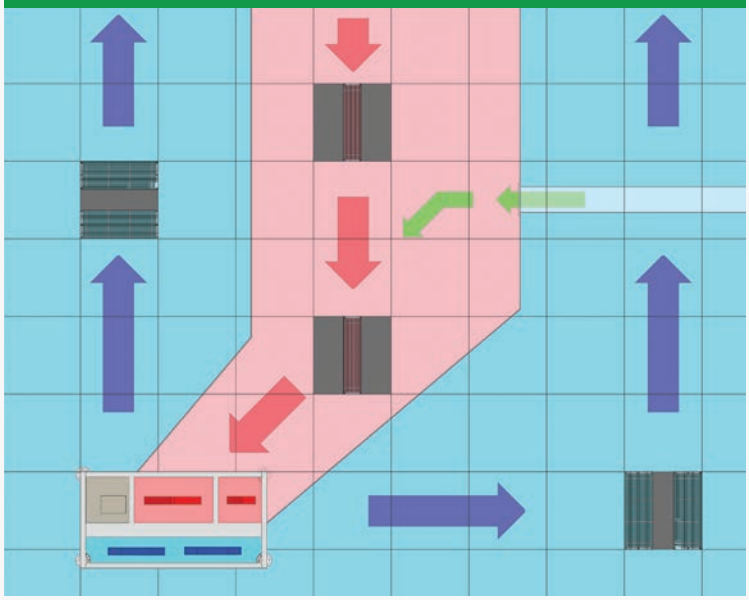
CAM-C

The unit is mounted on a baseframe which is used to divide supply and return air channels within the plenum. Six different designs can accommodate different airflow patterns as required with the most commonly used configurations shown in the schematics below.

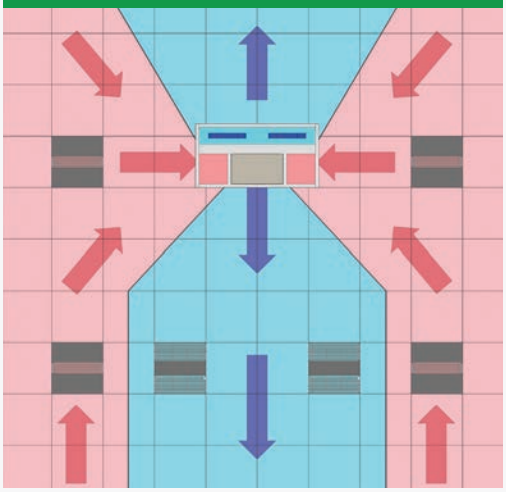
RECTANGULAR PLATE: CL



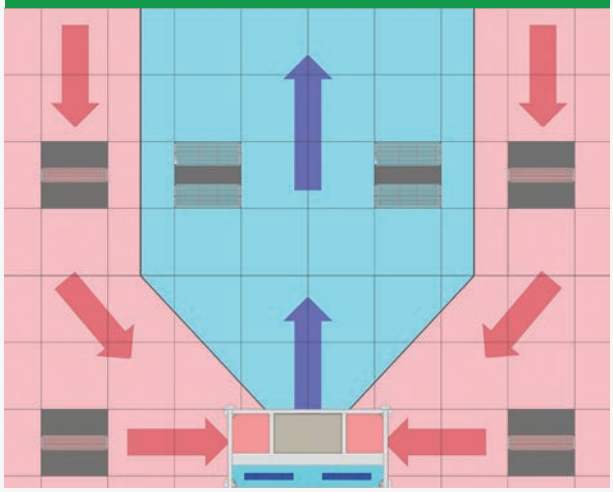
RECTANGULAR PLATE: CR



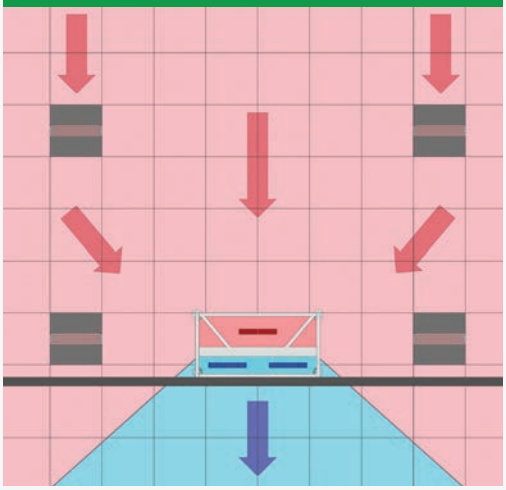
RECTANGULAR PLATE: DL



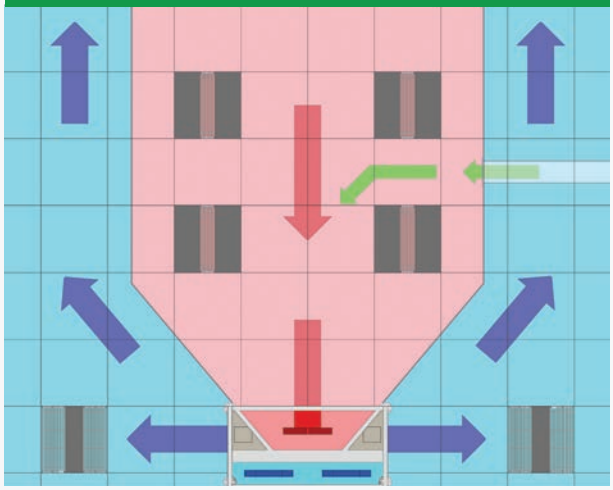
RECTANGULAR PLATE: FL



TRIANGULAR PLATE: DF OPEN



TRIANGULAR PLATE: DF CLOSED



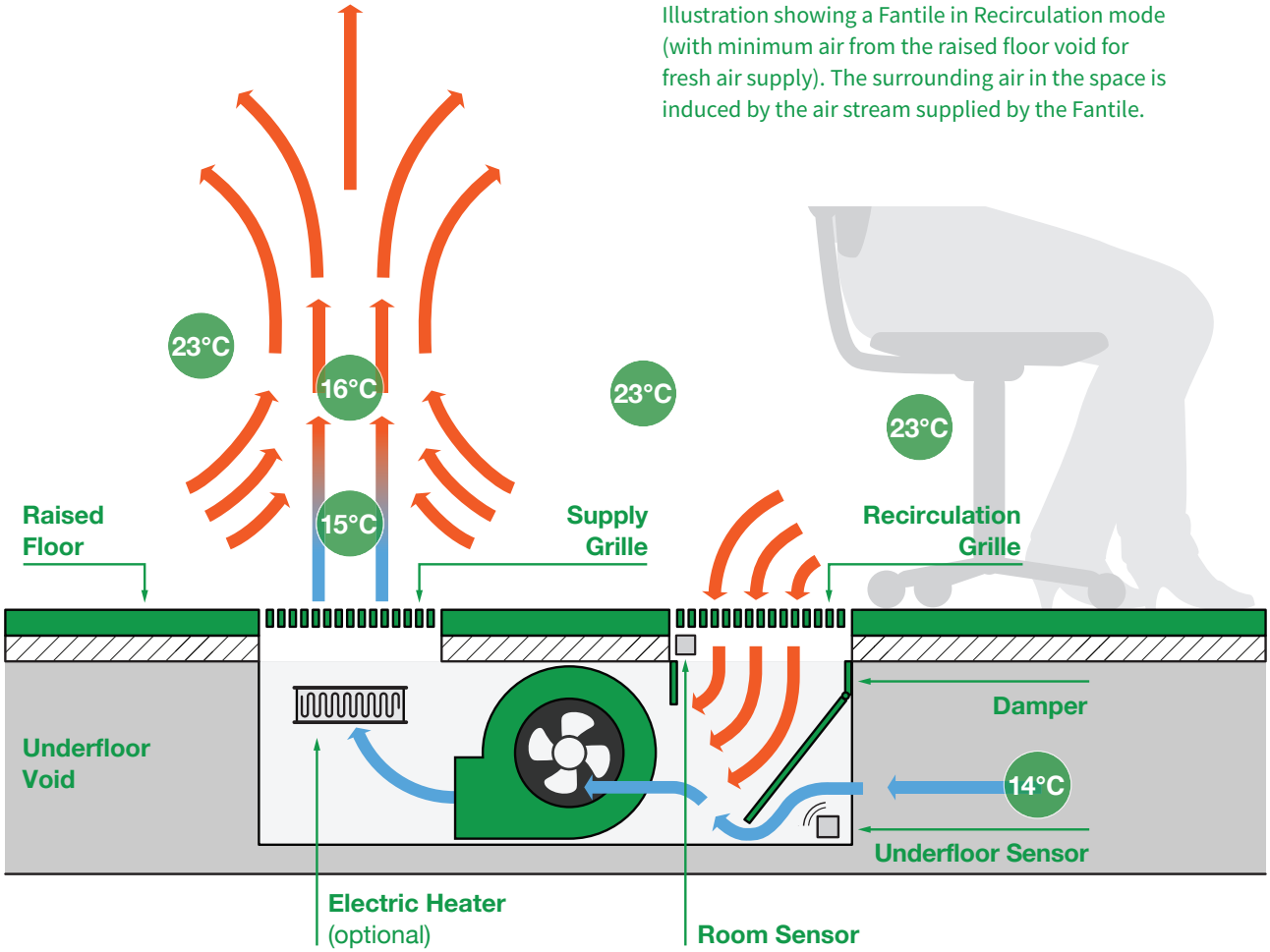
CAM-V

The unit is mounted on a standard baseframe with no airflow division required.

Fantile Airflow and Positioning

- Fan assisted terminal units will deliver between 20 and 160l/s air depending on fan speed selected
- Air velocity and air movement directly correlate to human comfort, therefore the positioning of fan terminal units is important
- Fantile spread should match perimeter & internal cooling loads. Position the supply grille nearest to the window
- Nearest Fantile to be a minimum of 2m from the CAM, with Fantile inlet at a minimum 90° to CAM
- Draughts as well as stagnant zones can be avoided by keeping a minimum space clearance of 300mm between the recessed terminal unit and the nearest occupant
- Proper air diffusion requires a mixture of primary and induced air streams
- Optional electric trim heaters can provide supplementary heating if necessary

Illustration showing a Fantile in Recirculation mode (with minimum air from the raised floor void for fresh air supply). The surrounding air in the space is induced by the air stream supplied by the Fantile.



Ventilation

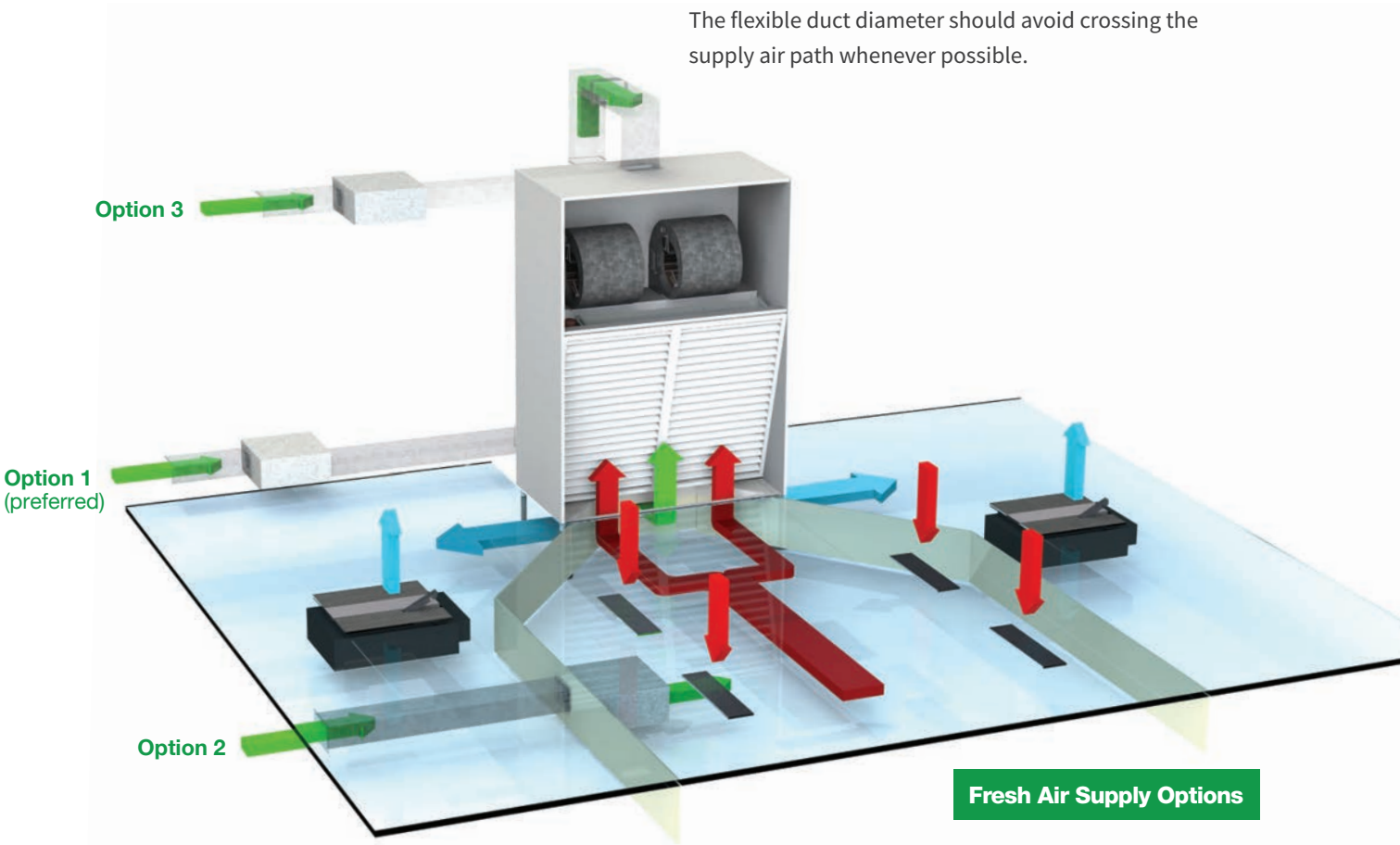
Fresh air can be pre-treated by using centralised units. The pre-treated fresh air can be supplied into the return section of the CAM, where it is mixed with the return air. Alternatively, the fresh air can be delivered directly to the space.

Fresh air may also enter untreated into the return section of the CAM, in which case it will be treated by the coil after mixing with the ambient return air.

Fresh air can also be treated by decentralised fresh air modules located in the raised floor void. These draw fresh external air directly from the buildings' façade or distribution riser, and deliver it into the return air path. The units can also be used as extract units in various applications, or to boost airflow within large areas of the supply zone.

The unit must be placed in the return section of the underfloor circuit allowing the outdoor and return air to mix. This avoids the internal space conditions being directly affected by the temperature of the outside air. Any ducts should run parallel to the underfloor baffle. Crossing of the underfloor air circuit may affect the CAM performance if the ducts obstruct the airflow.

The flexible duct diameter should avoid crossing the supply air path whenever possible.



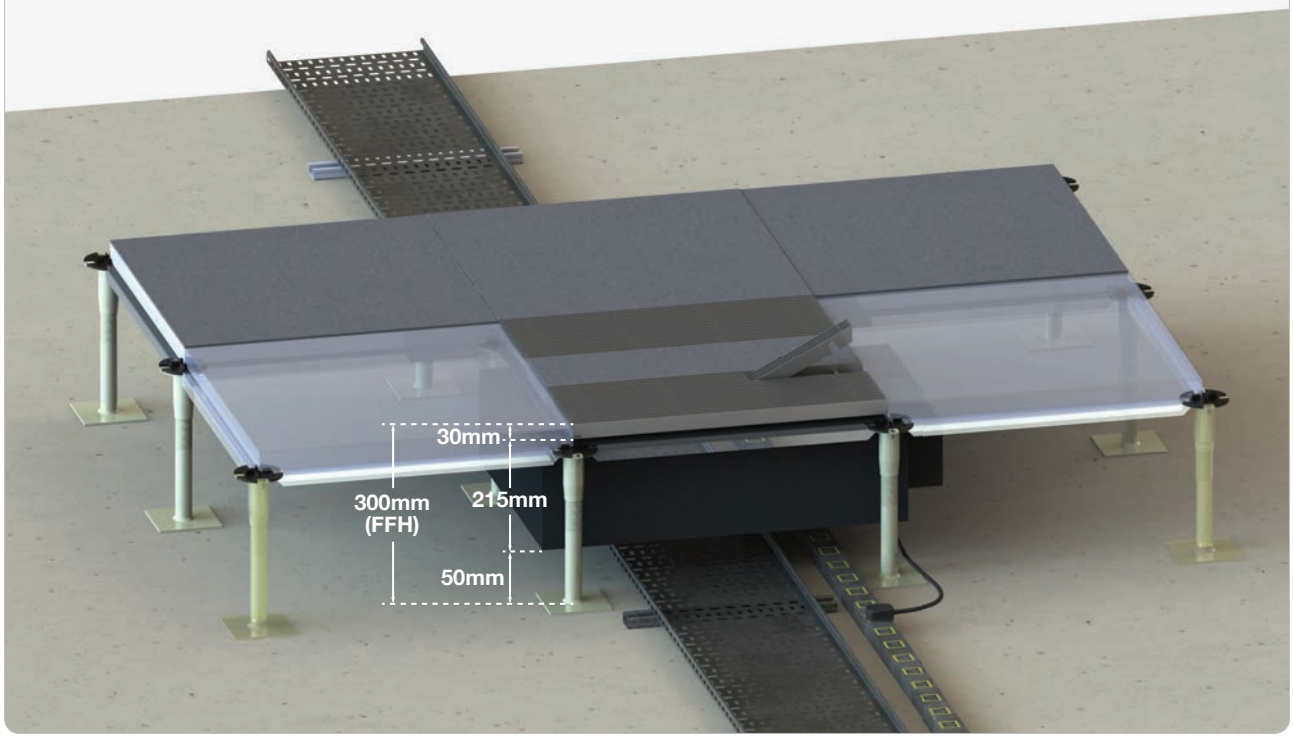
Fresh Air Supply Options

The Raised Access Floor System

The raised access floor creates the underfloor plenum which becomes the ventilation zone for the supply (and return, CAM-C only) of conditioned air. Incorrect specification could potentially affect the UfAC system's performance.

Floor Plenum

- The raised floor net height can limit or modify the air flow characteristics. As a rule, the lower the net height, the shorter the underfloor air route should be
- The slab finish has little influence on the thermal behaviour of the system. However, a smooth slab surface facilitates the airflow
- Air leakage from the raised floor void should not exceed 2% of the underfloor airflow
- Congested plenums will affect the airflow and consequently the system performance
- Fantiles require power tracks evenly distributed within the underfloor plenum with automatic shutoff in case of fire
- The addition of power modules will affect the available plenum height. Care should be taken if the slab is very uneven



Floor Substructure

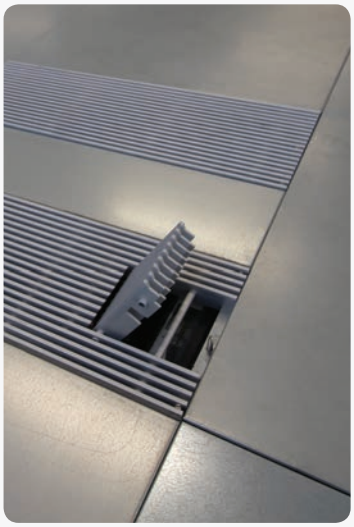
- Pedestal heads must be of suitable size and shape with slots to accommodate stringers. There should be no hole in the centre of the head in order to support the grille height adjustment screw
- The stringer gasket should cover the length of the stringers to ensure air tightness
- Different size stringers using the same pedestal are available. Medium strength stringers are normally recommended
- The substructure must not interfere with Fantile and underfloor partition installation. The head gasket must be conductive to ensure electrical continuity

Floor Finishes

Special consideration should be given to the final finishes and floor coverings to ensure continued flexibility. 600mm modular floor finishes are recommended and prefabricated high class finishes such as Granite, Marble, Stone, Glass, Natural Oak and Teak are available.

Floor Grilles

Designed to be part of the walkable surface, light aluminium alloy grilles are used for the supply, recirculation and return (CAM-C only) air grilles and are height adjustable to fit level with different floor finishes. Circular or custom shape grilles and different colour finishes are available on request.
Supply Grilles feature hatch access to the Fantiles' integrated controllers.



Controls Overview

Flexible Space systems can be controlled in a number of ways. CAMs and Fantiles can work independently or connected in a network. Networks can be connected to proprietary visual communications software and/or a central BMS for remote monitoring.

Fantiles – Integrated Fatronic

Each Fantile comes with an integrated Fatronic controller as standard, permitting personal user control of temperature and fan speed. Master-Slave function [1 Master to 7 Slaves] is available for large zones with multiple units.

Fantiles – Flextouch (wall mounted, optional)

Wall mountable, touchscreen remote controller for Fantiles which allows user adjustment of fan speed and temperature and measures CO_2 and humidity.

PIR sensor detection available. Master-slave function available for large zones with multiple units.

Central Monitoring (Flexvisor)

Software is available for independent remote monitoring and supervision, with local access using network IP addresses, or remote access using remote access web addresses.

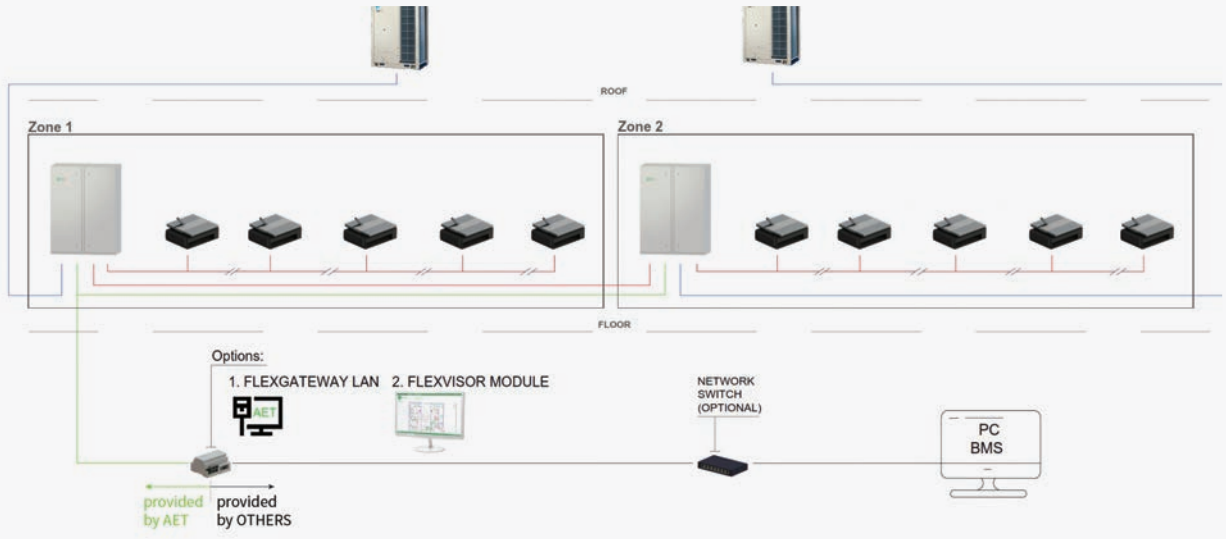
CAM-C/CAM-V (Flexface-Flexmatic)

CAMs feature integrated Flexface control boards. An optional Flexmatic display unit allows direct visual access and control of up to 16 networked CAMs [8 if connected to a central BMS] and associated Fantiles.

Gateways for linking to BMS

The Flexgateway interface module can connect the system to either the Flexvisor software, or to a central BMS using either Modbus or BACnet protocol.

SCHEMATIC REPRESENTING A TYPICAL UFAC SYSTEM CONNECTED TO VRV HEAT PUMPS



Case Study:
8 Waterloo Place, London

Project Team

Architect
Morrow & Lorraine

Consultant
Watkins Payne Partnership

Main Contractor
Scott Osborn

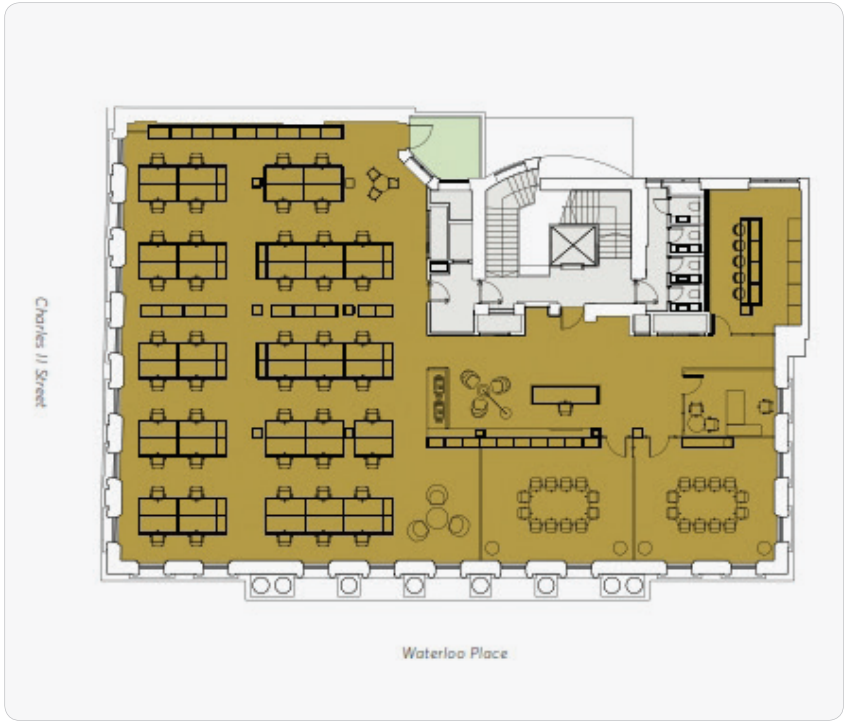
Developer
Barings

Building characteristics

- Grade II listed
- Ornate vaulted ceiling
- Existing 300mm floor void
- Varying floor to ceiling heights between floors

Design Criteria

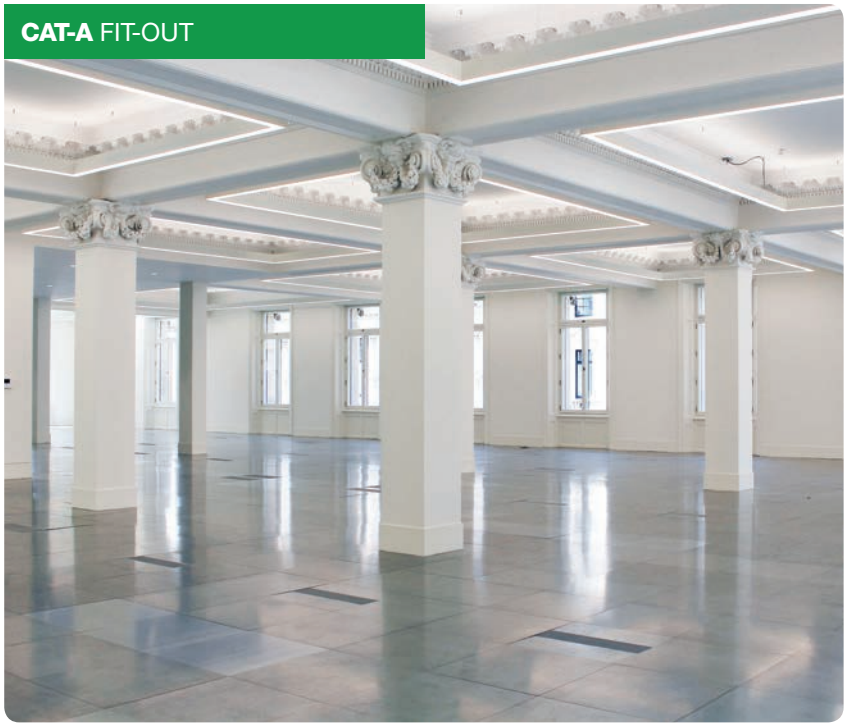
- Exposed ceiling
- No services at high level
- Retain existing ceiling cornices
- Bi-directional lighting
- Maximise floor to ceiling heights



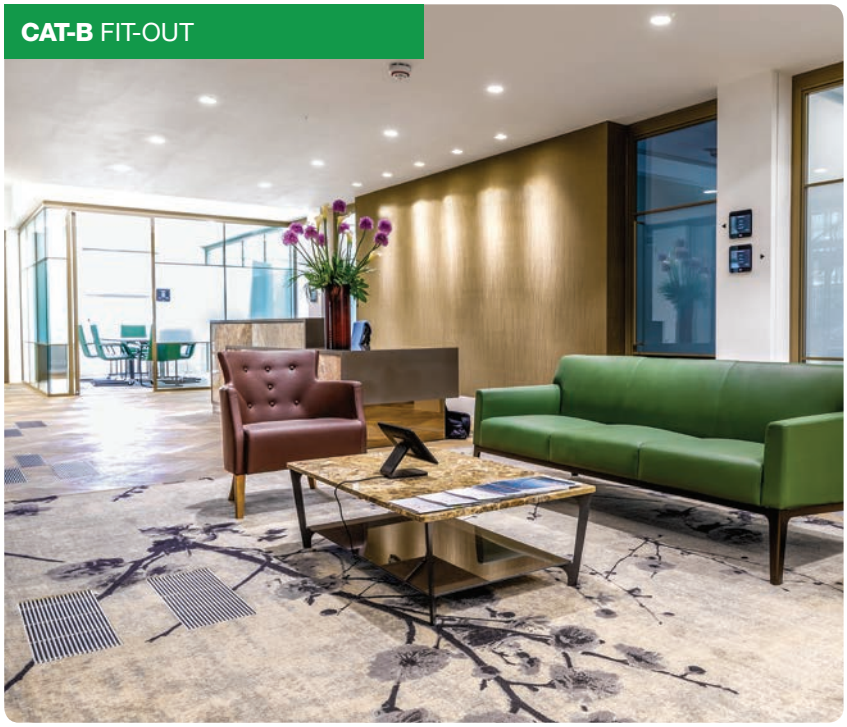
33,000 sq. ft. Completed 2017. Cat B fit-out completed 2018

Restoration of existing historic fabric with the addition of contemporary finishes and building services, permitting the ceiling to remain exposed.

CAT-A FIT-OUT



CAT-B FIT-OUT



Project Outcome

The speculative refurbishment was successful in attracting high profile occupants quickly after completion, who have since proceeded with Cat-B fit-out works of the highest quality, retaining and highlighting the building's unique characteristics. Barings Real Estate commented, "We have created a truly special building which is being reflected in the high levels of rent we are achieving."

Selected Case Studies

42 Berners Street, London

By adopting UfAC in the redevelopment of 41-44 Berners Street, the architects were able to fit in an additional floor and increase the available nett lettable space, yet remain within the existing planning constraints of the project.

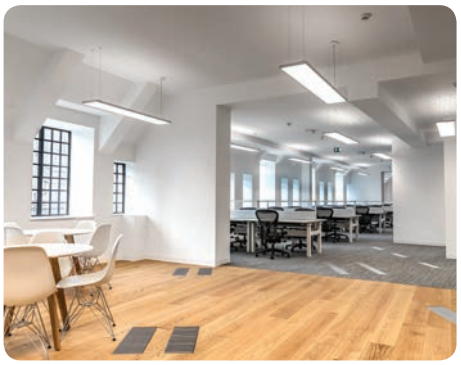
Here East, Queen Elizabeth Olympic Park, Stratford

UfAC was successfully integrated with other services at this award winning project. The CAM-V enclosures were aesthetically designed to be part of the signage in the public areas and were level with the mezzanine floor.

Sky Central, Osterley

The highly accredited, expansive building is cooled by Displacement Ventilation, with the addition of Fantiles to enhance cooling and control in the cellular meeting pods.

33 Glasshouse Street, London

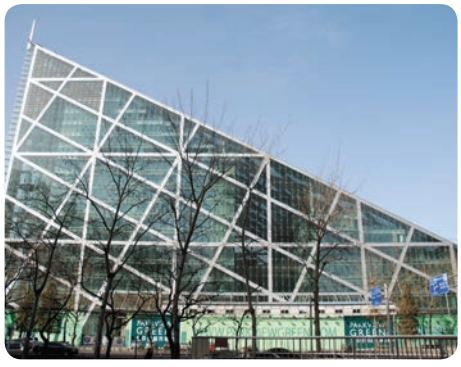


This “cut and carve” project underwent substantial structural reconfiguration to form larger, open plan floorplates. Floor to ceiling heights were maximised, light levels increased, and a large open plan floorplate was created with the adoption of UfAC.

The University of Essex, Colchester Campus

A low energy, comfort cooling system that could satisfy both high and transient occupancy levels and adapt to future change of use within the mixed use space was specified by the client.

Parkview Green, Beijing



The building has unique architectural form with a pyramidal roof and comprises four buildings arranged in a cluster with atrium spaces set in between the buildings. Office areas are air-conditioned using Fantiles.

Flexible Space
Under Floor Air Conditioning

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