Cool phase®

Natural Cooling and Low Energy Ventilation System

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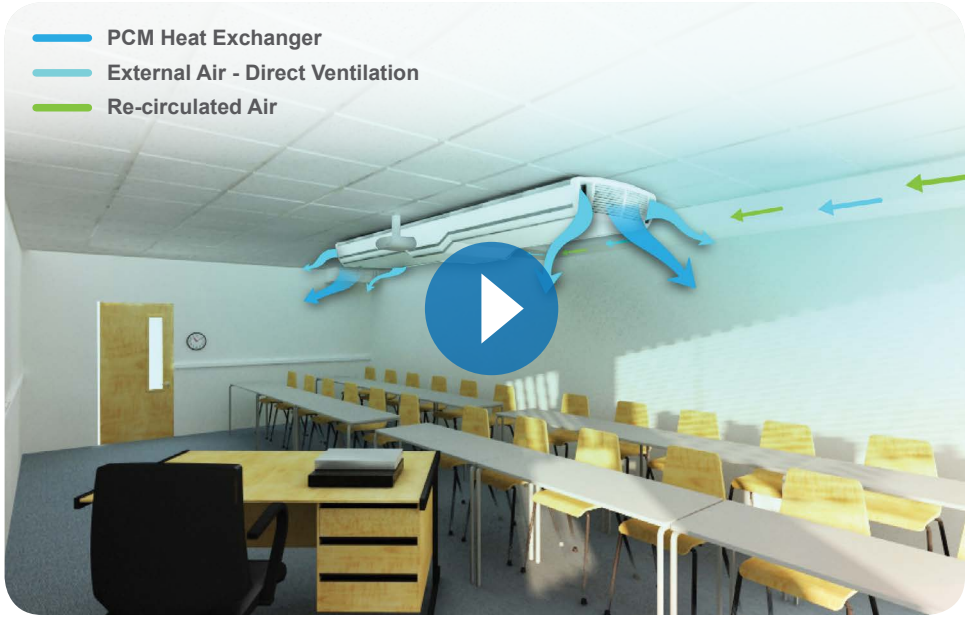
Cool-phase®

Cool-phase **is a low energy cooling and ventilation system** that creates a comfortable, fresh and healthy indoor environment and reduces the running costs of buildings.

Cool-phase uses a thermal energy store utilising a **Phase Change Material (PCM)** in combination with an intelligently controlled Air Handling Unit to actively ventilate and cool the building. **The Cool-phase system can maintain temperatures within the comfort zone, while radically reducing energy consumption by up to 90 %, compared to a conventional cooling system**. Unlike conventional cooling approaches, **Cool-phase uses no refrigerants** making it an environmentally sound solution to cooling our buildings.



BENEFITS of the Cool-phase system over conventional HVAC systems

- **Low Running Costs:** The system has low servicing, maintenance and energy costs, combined with a long life that provides an impressive payback on the capital cost of the system.
- **Energy and carbon saving:** The Cool-phase system uses an energy efficient variable speed fan with no compressors, pumps or other energy intensive components. A 5A single phase mains supply is all that is required.
- **Healthy and productive:** The Cool-phase system creates a healthy and productive environment by monitoring internal air quality and ensuring there is a supply of fresh air.
- **Modular design:** The Cool-phase system can be installed in modular spaces or large open plan offices, above a false ceiling or suspended below to suit a range of environments. **It can also be installed and integrated with new or existing mechanical ventilation and cooling schemes to offer local decentralised ventilation whilst taking over some of the cooling duty thus improving air quality and lowering running costs.**
- **Performance:** The Cool-phase system is able to reliably meet both requirements for thermal comfort, energy, efficiency and ventilation, even in the toughest of scenarios.
- **No external units:** Cool-phase does not require any external units. This makes Cool-phase particularly suitable in applications where access to outside space or planning constraints are an issue and has a positive impact in terms of external acoustics.
- **No refrigerants:** The Cool-phase system does not use the coolants often found in conventional cooling approaches. Therefore Regulations controlling the use and disposal of refrigerants do not apply to Cool-phase.
- **Long life**: With a design life in excess of 20 years and a warranty of 5 years, the system provides customers with the reassurance that they have a long term solution to their cooling and ventilation needs.

APPLICATIONS

The Cool-phase system can be installed in **all Commercial sectors**; new buildings or retrofit to existing ones, from small modular areas to large open plan rooms. The system can be suspended below a ceiling (a floor to ceiling height of 2.6 m or greater is recommended for the **Fascia System**), within a false ceiling void (a minimum ceiling void of 400 mm is required for the **Suspended Ceiling System**) or to an **Exposed Void** where the unit and duct work is supplied in a matte black finish.

Offices

The Cool-phase system has been designed to meet the requirements of clients who wish to have a greater level of control over internal temperatures than is achievable with other low energy approaches, but without the high energy and maintenance costs of conventional cooling solutions.

Corporate

The Cool-phase system can operate on its own to provide thermal comfort conditions or can operate alongside conventional cooling systems to provide fine level of climate control that even the most demanding client might expect, but still radically reduce running costs.

Retail

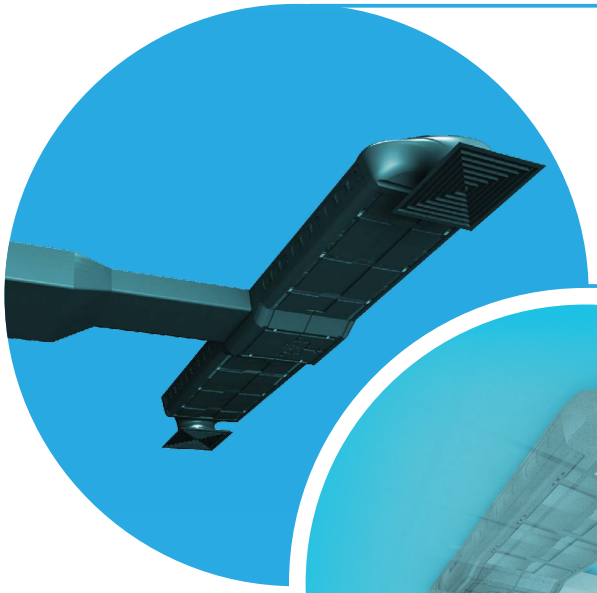
Retailers are under increasing demand to slash their energy consumption and Cool-phase has been shown to make significant savings compared to conventional cooling approaches.

Education

Each Cool-phase system includes CO_2 monitoring as standard and can accurately control the level of fresh air within classrooms to provide the ideal teaching environment. The system is capable of meeting the requirements of BB101 and Priority School Building Programme (PSBP) even in tough areas, such as an IT classroom.

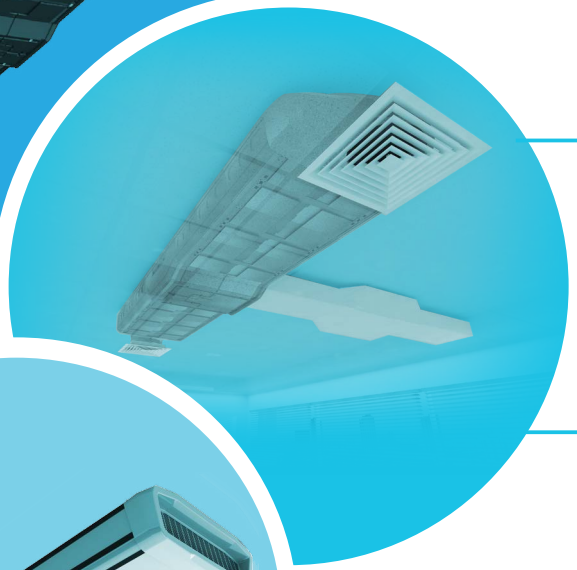
The Cool-phase system is not suitable for locations that are occupied 24 hours a day or domestic premises

OPTIONS



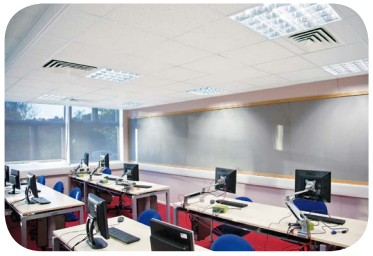
Cool-phase Exposed Void

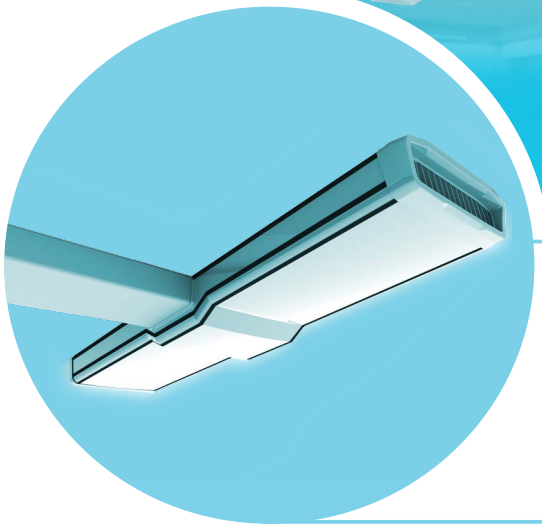
For exposed structure or open plenum applications, Cool-phase can be installed in a more subtle fashion to the “Fascia” model. Fascia’s and grilles are replaced by two 90° down turns and 4 way diffusers to allow the **system to sit unnoticed in a plenum.**



Cool-phase Suspended Ceiling

Cool-phase can be installed **above suspended ceilings** with a void of at least 400 mm to completely conceal the unit. Air is cooled and distributed via ceiling diffusers to provide cool, fresh air to the area below. The system can be installed flush to the slab or suspended from larger voids.





Cool-phase Fascia

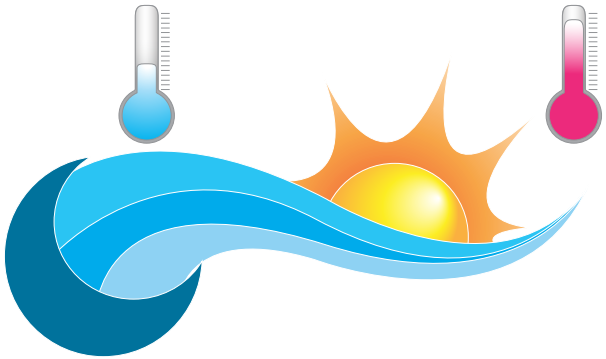
In applications where Cool-phase is **on display**, the system is fitted with covering fascia panels and high quality grilles to give Cool-phase a smooth, contemporary aesthetic. The system can also include an optional LED “shadow gap” lighting feature to display the charge of the system throughout the day.

HOW IT WORKS

The Cool-phase system uses the concept of a **'Thermal Battery'** to capture and store heat. The Thermal Batteries use the latent heat property of materials to store large amounts of energy, which is charged and discharged by passing air through a heat exchanger. Materials that change phase at room temperature are frequently referred to as **Phase Change Materials (PCMs)**.

Comfort Cooling

In the UK, even in the summer, there is a 10 to 15 °C temperature difference between day and night time temperatures; this is known as the **diurnal cycle**. At night, cool outside air is passed through the heat exchanger recharging the Thermal Batteries and releasing the heat built up during the previous day. As temperatures rise, room air is passed through the heat exchanger to provide cooling. The total cooling provided is a combination of the use of the thermal energy stored within the unit, the effects of free cooling, and night time ventilation.



Ventilation

Cool-phase works all year round to ensure a fresh and healthy environment, monitoring temperature and CO_2 levels to automatically determine how much ventilation is required.

Heat Recovery

In winter, the Cool-phase system works in reverse, trapping waste heat and using it to warm up cool fresh air entering the building. Whenever the internal temperature exceeds a preset level, or at the end of the day when the space is unoccupied, warm air from inside the space is passed through the heat exchanger, charging the Thermal Batteries. When ventilation is required, cool air from outside is passed through the heat exchanger, warming the air entering the space and reducing the load on the heating system.

Intelligent Thermal Mass

A building with a low thermal mass heat up quickly. Cool-phase adds thermal mass to buildings which is intelligently controlled to maximise performance

The effect of adding thermal mass to a building is a well understood principle, effectively increasing the time that it takes heat gains to raise the temperature of the building. When combined with measures to control internal and external heat loading, it can be a very effective method of ensuring that the building meets requirements for thermal comfort.

However during a period of hot weather, temperatures will invariably rise over time, as there is no method of actively dissipating the build-up of heat. Therefore the effect of adding thermal mass can diminish over a warm spell, although the building takes longer to heat up during the day, it will also take longer to cool down at night time and therefore not all of that heat may be dissipated by the following day.

Unlike passive applications where thermal mass is simply added to a building, **the Cool-phase system is able to intelligently control how energy is stored and released from the thermal store, by using a heat exchanger and mechanical ventilation.** The heat built up during the day can therefore be released at night and the thermal energy store recharged.

When this is combined with the effects of free cooling and night time ventilation, the result is a system that can reliably **maintain temperatures within comfort zones while radically reducing energy consumption by as much as 90 %** compared to a conventional cooling system.

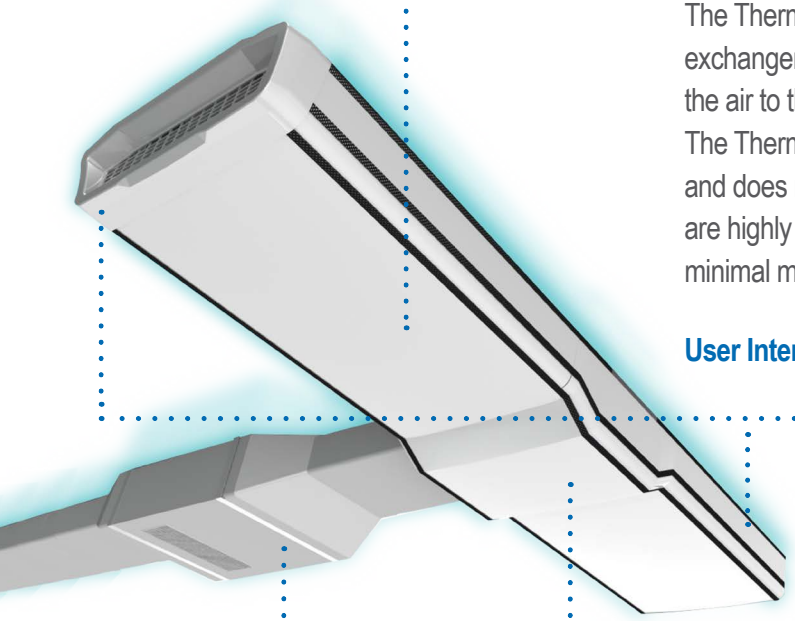
Monodraught has an extensive knowledge of how Phase Change Materials (PCMs) can be utilised within buildings. Since the process of changing phase and getting energy in and out of PCMs is complex and requires a carefully controlled heat exchange process, simply trying an off-the-shelf PCM such as ceiling tiles combined with natural or mechanical ventilation often results in a system that fails to perform as expected. The Cool-phase system has therefore been designed from the ground up to maximise performance of the PCM by utilising a self-contained heat exchanger, bespoke control system and Air Handling Unit.

A building with a high thermal mass takes longer to heat up but also to cool down

Cool-phase Fascia, Suspended Ceiling & Exposed Ceiling Void

> Back to Options

Cool-phase Fascia - Key Features



Modular Thermal Battery

The Thermal Batteries form a modular heat exchanger. This allows heat to be transferred from the air to the Thermal Batteries, or vice versa. The Thermal Battery module has no moving parts and does not require any power, therefore, they are highly reliable, have a long life and require minimal maintenance.

User Interface

Diffusers & Fascia

Air diffusers are built into the units to ensure air can circulate around the room evenly and prevent uncomfortable draughts.

Duct

An acoustic insulated duct connects the Cool-phase system to the outside air.

Air Handling Unit (AHU)

The Air Handling Unit (AHU) contains an energy efficient EC fan, control, actuator, intelligent control system and sensors. The control system monitors indoor air quality, temperatures both inside and outside, and humidity levels. The AHU controls the flow of air into the building, and how energy is released or stored by the Thermal Batteries.

Re-circulation Module: A G4 filter is positioned to remove particles from the incoming external air and re-circulated air. Volume control dampers manage the proportions of fresh and re-circulated air to maintain the optimal internal environment. Pressure sensors to indicate when dirty filter media needs to be cleaned or replaced.

Exhaust Grille: An outlet for air to leave the space is required.

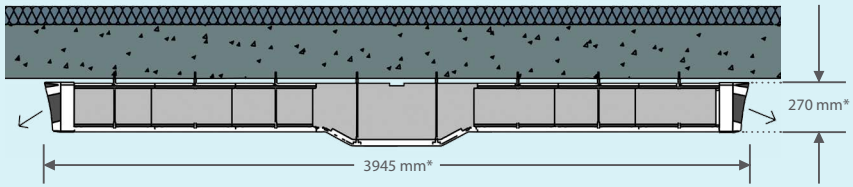
CASE STUDY

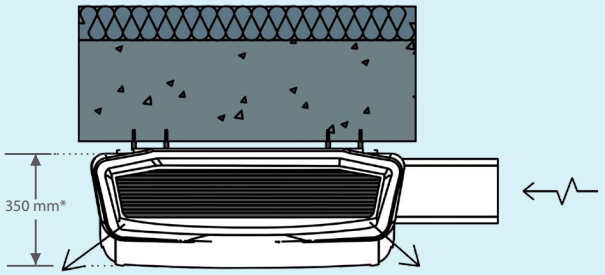
E1 Business Centre & Holywell Centre

The first iteration of Cool-phase ceiling mounted units were installed in two serviced offices in central London for Workspace plc in 2009. They have proven to be a great success, resulting in a significant reduction in the peak temperatures recorded during the summer.

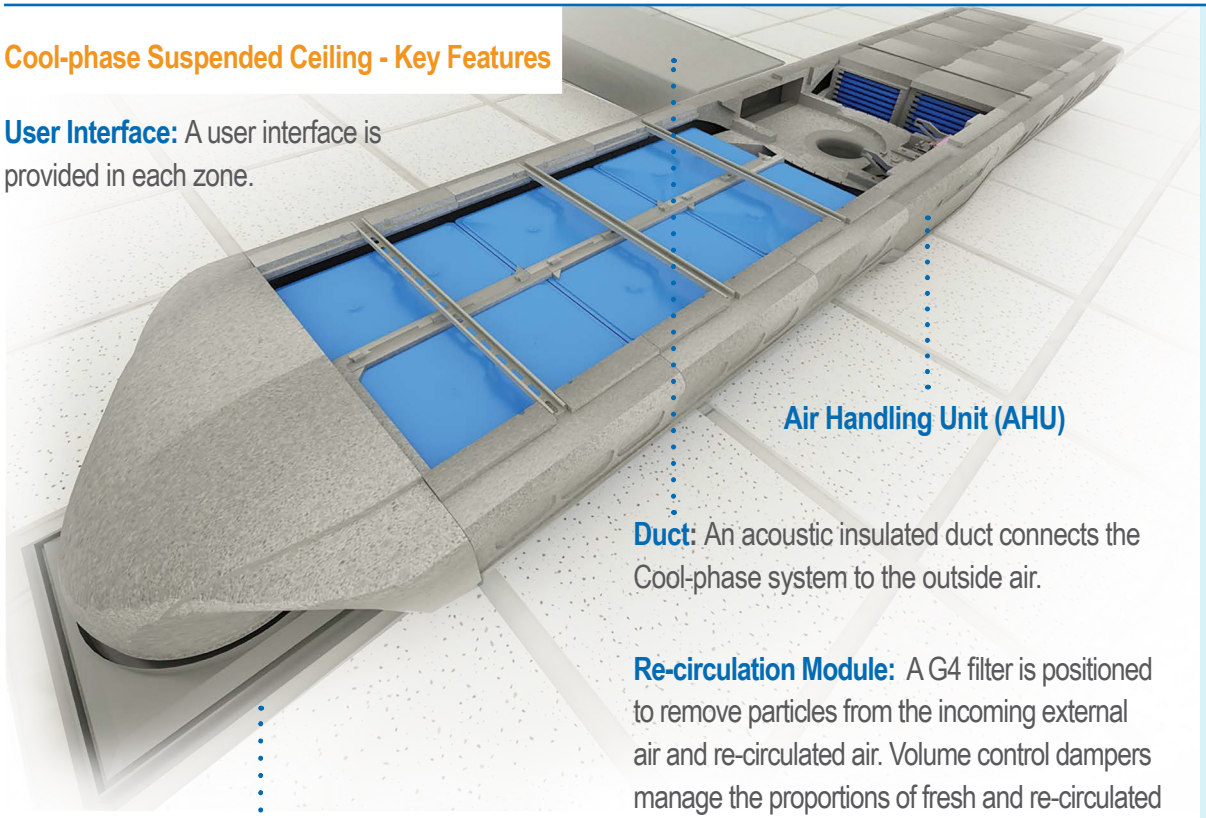
FASCIA SECTION VIEW

*CPN6F Approximate Weight: 300 kg





Cool-phase Suspended Ceiling - Key Features



User Interface: A user interface is provided in each zone.

Duct: An acoustic insulated duct connects the Cool-phase system to the outside air.

Re-circulation Module: A G4 filter is positioned to remove particles from the incoming external air and re-circulated air. Volume control dampers manage the proportions of fresh and re-circulated air to maintain the optimal internal environment. Pressure sensors to indicate when dirty filter media needs to be cleaned or replaced.

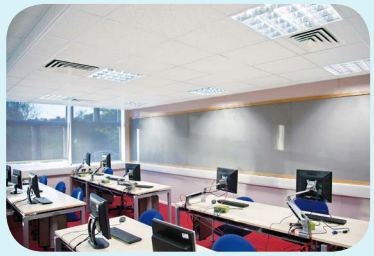
Ceiling Tile Diffuser: When the system is mounted above a false ceiling, ceiling tile diffusers are used at the end of the PCM module. Inlet grilles are provided at the point where air is re-circulated.

Exhaust Grille: An outlet for air to leave the space is required. This can be through an internal exhaust grille, which allows air to escape through the rest of the building or through a second external weather louvre with volume control damper.

Modular Thermal Battery:
The Thermal Batteries form a modular heat exchanger. This allows heat to be transferred from the air to the Thermal Batteries, or vice versa. The Thermal Battery module has no moving parts and does not require any power, therefore, they are highly reliable, have a long life and require minimal maintenance.

CASE STUDY

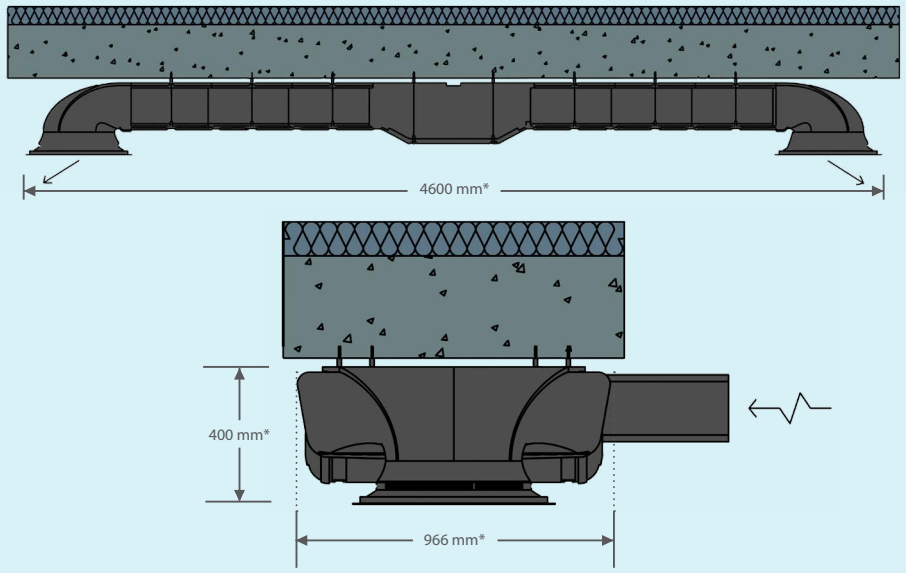
Scarborough Sixth Form College



The newly refurbished IT classroom at Scarborough Sixth Form College uses the first iteration of a single Cool-phase unit discreetly hidden within the ceiling void. The classroom quickly saw an improvement in air quality following installation, with a significant reduction in CO_2 levels.

SUSPENDED CEILING SECTION VIEW

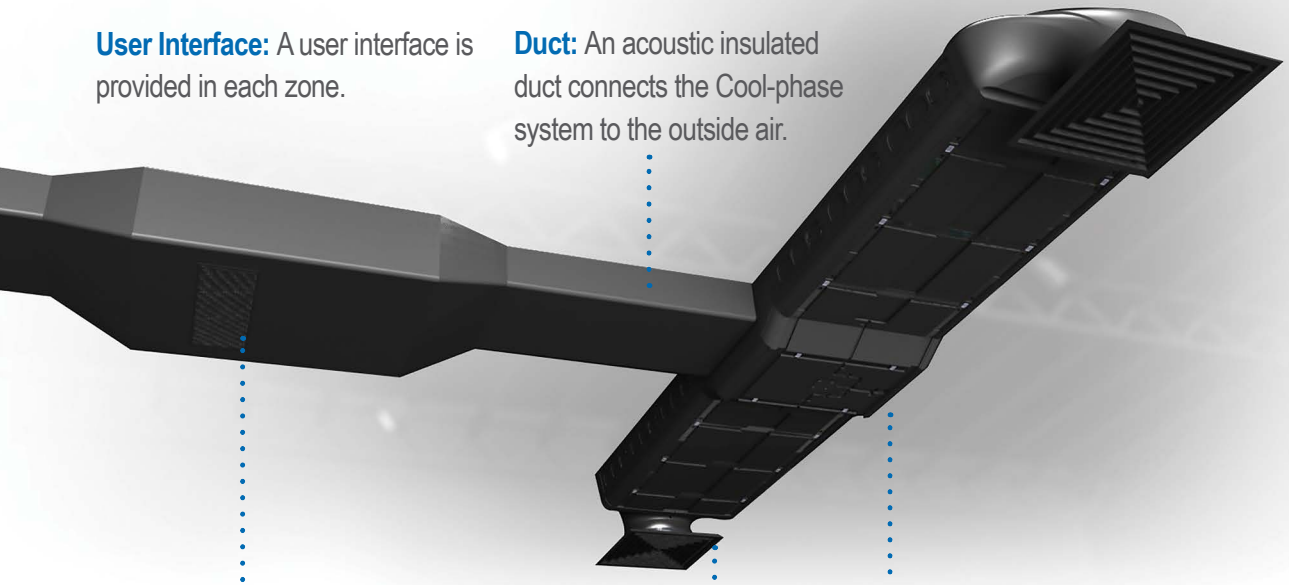
*CPN6SC Approximate Weight: 285 kg



Cool-phase Exposed Void - Key Features

User Interface: A user interface is provided in each zone.

Duct: An acoustic insulated duct connects the Cool-phase system to the outside air.



Re-circulation Module: A G4 filter is positioned to remove particles from the incoming external air entering the building. Volume control dampers manage the proportions of fresh and re-circulated air to maintain the optimal internal environment. A pressure sensor is situated downstream from the filter housing to indicate when dirty filter media needs to be cleaned or replaced.

Air Handling Unit (AHU)

Ceiling Tile Diffuser: Ceiling tile diffusers are used at the end of the PCM module. Inlet grilles are provided at the point where air is re-circulated.

Exhaust Grille: An outlet for air to leave the space is required. This can be through an internal exhaust grille, which allows air to escape through the rest of the building or through a second external weather louvre with volume control damper.

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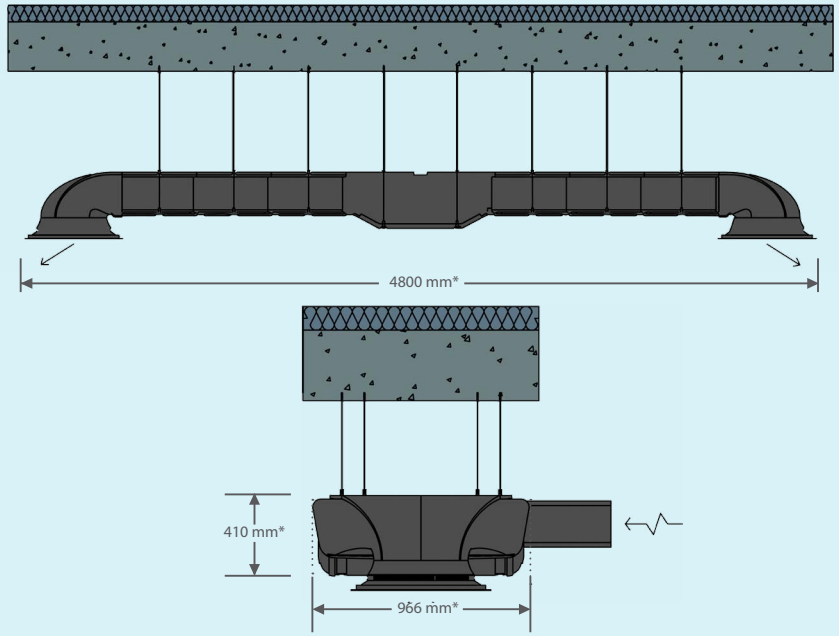
Applications

Exposed Ceiling Void

For exposed structure or open plenum applications, Cool-phase can be installed in a more subtle fashion to the “Fascia” model. Fascia’s and grilles are replaced by two 90° down turns and 3 way diffusers to allow the **system to sit unnoticed in a plenum.**

EXPOSED CEILING VOID SECTION VIEW

*CPN6EV Approximate Weight: 285 kg



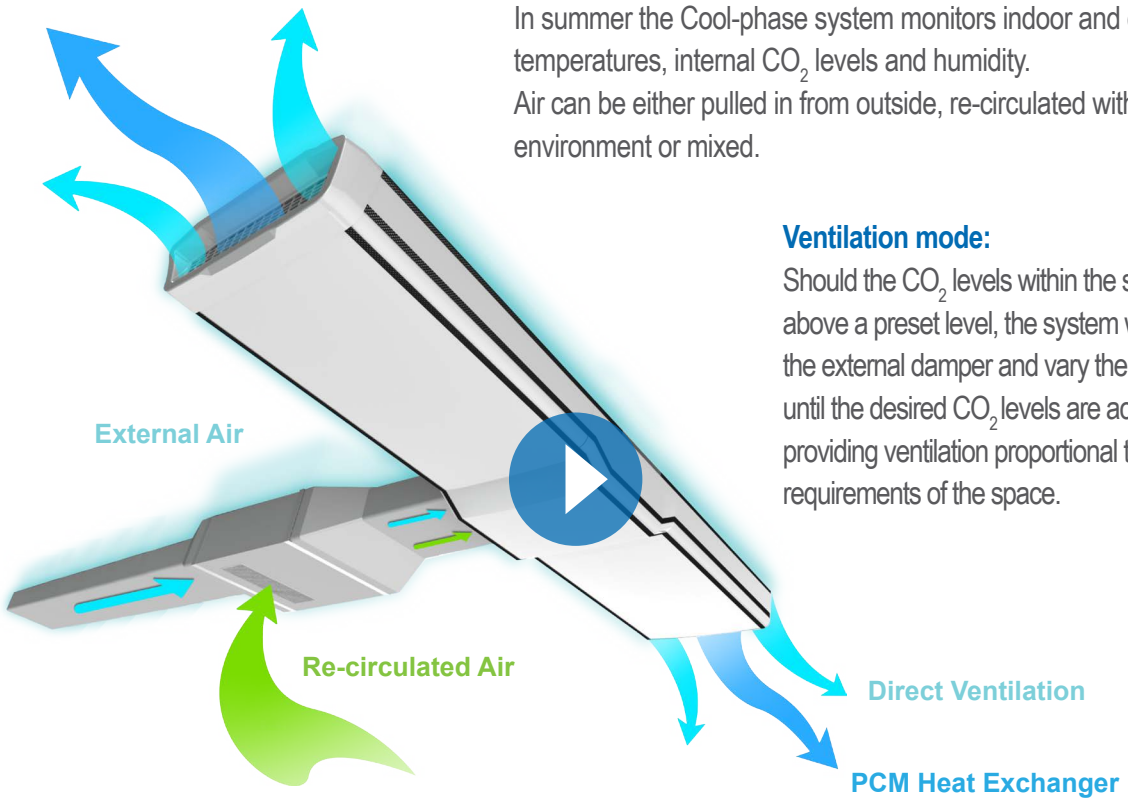
COMFORT COOLING

Operating modes:

In summer the Cool-phase system monitors indoor and outdoor temperatures, internal CO_2 levels and humidity.
Air can be either pulled in from outside, re-circulated within the environment or mixed.

Ventilation mode:

Should the CO_2 levels within the space rise above a preset level, the system will open the external damper and vary the fan speed until the desired CO_2 levels are achieved, providing ventilation proportional to the requirements of the space.



Summer charge mode:

When the room is unoccupied at night, the system will automatically pull in external air and pass it through the heat exchanger to cool the Thermal Batteries, recharging the system and dissipating the build-up of heat from the previous day.

This also has the effect of cooling the fabric of the building down; increasing the cooling effect for the following day. The system will alter the charge rate and length of charge depending on the temperature of the outside air, switching off when the Thermal Batteries reach the full capacity.

Cooling Mode

Should the temperature in the room exceed a preset level, the system will provide cooling to meet the requirements of the space, varying the damper positions and fan speed:

- **Direct outside air ventilation:** This is used when the outside air temperature is low enough to overcome any overheating in the room, air is passed directly from outside into the space bypassing the Thermal Batteries. Using this function reduces the loading on the fan and preserves the cooling capacity of the Thermal Batteries for when it is most needed.

- **Outside ventilation and cooling:** This is used when the temperature differential between inside and outside air is insufficient to cool the space but the outside temperature is still lower than the temperature within the room. Air is passed from outside over the Thermal Batteries to drop the temperature of the air and cool the room sufficiently.

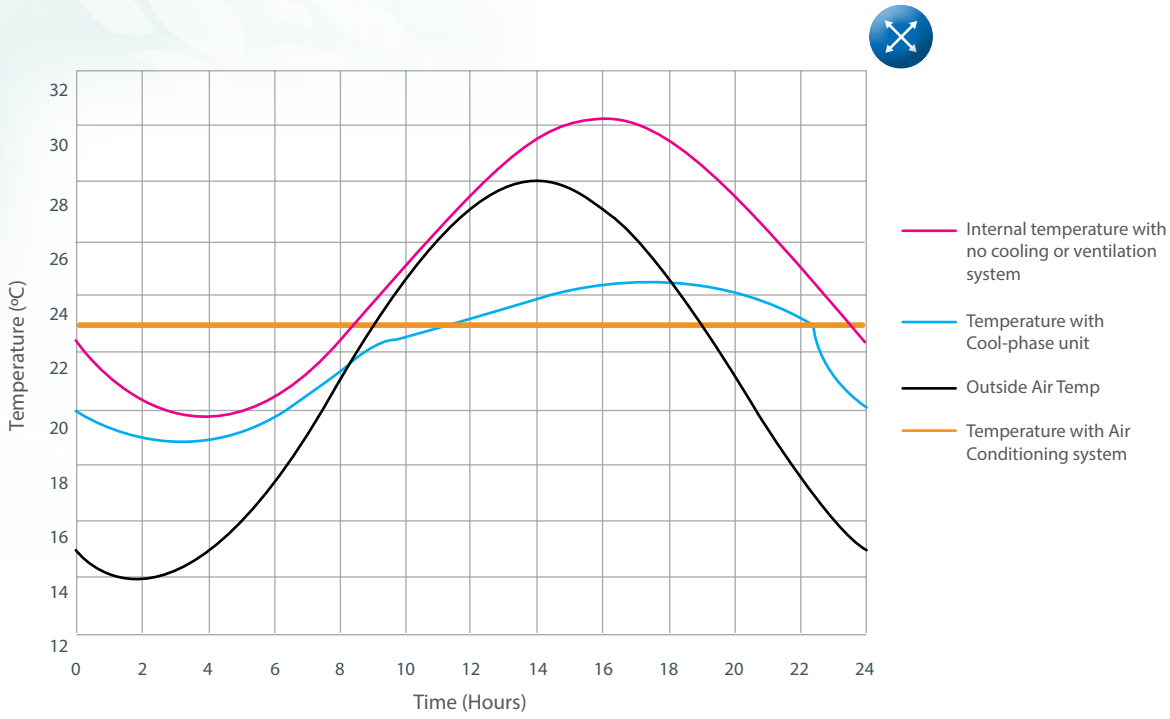
- **Re-circulation and cooling:** This strategy is used when the temperature outside is higher than inside, the unit re-circulates air from within the room and passes it over the Thermal Batteries to provide cooling. A proportion of air is drawn from outside to maintain ventilation levels, a CO_2 sensor and preset level determines the minimal amount of ventilation to be provided.

Total Cooling = Free Cooling (Ventilation) + Night time Cooling (Building + flush) + Thermal Batteries (Energy stored)

The total cooling over a 24 hour period is the sum of the free cooling (when it is cooler outside than inside), the effects of night time cooling (when the fabric of the building is cooled down and the heat built up during the previous day is dissipated), and the use of the energy stored within the Thermal Batteries to temper the air.

The graph on the right shows the **performance** of the system in a simplified model. **The black line shows the external temperature** varying between 14 °C at night and 28 °C during the day. **The temperature in the building, with no cooling or heating, is shown by the pink line** and peaks around 30 °C.

The blue line shows the temperature within the same space with Cool-phase installed, showing a significant reduction in the peak temperatures. The Cool-phase system is not designed to match the outright performance of the Air Conditioning (AC) system, which is typically specified to maintain a temperature of 23 °C; however it has resulted in an 80 to 90% improvement in temperature for 10% of the energy usage of the AC system. When fine levels of temperature control are required, the Cool-phase system can be used alongside a conventional cooling solution to reduce the overall energy usage.



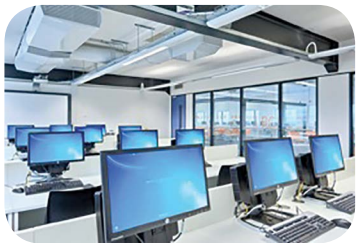
Graphic showing the performance of Cool-phase in a simplified room model

CASE STUDIES

Prospects College (Fascia)

Ayshford Sansome Associate Rob Westbrook: *"Monodraught emerged as the preferred candidate, meeting our brief in terms of cost, sustainability and the potential as an educational source"*. The final design included Cool-phase due to the expected heat gains.

Image courtesy of Andrew Hatfield at www.andrewhatfield.co.uk



Sheffield Hallam University (Suspended Ceiling)

The system has dramatically reduced CO_2 levels and is controlling previously excessive room temperatures well within normal comfort zones. All this while reducing energy consumption by up to 90 % compared to conventional mechanical cooling systems.

Anglia Ruskin University (Suspended Ceiling)

Two Cool-phase systems were installed in the Bryant building. The combined usage was 197.6 KWh of electricity across the thirty one week data logging period. Assuming a standard electricity tariff of 0.11£/KWh, that amounts to **total energy costs of £21.74**, or just **70p a week for the two Cool-phase units.**

University of East London (Fascia)

Monodraught Cool-phase units were installed in three computer suites at the Stratford Campus to reduce high heat gains from IT equipment and people.

SPECIFICATION & CONTROLS

Performance Specification:

- **Normal ventilation rate (occupied hours):** between 0.1 to 0.26 m³/s.
- **Maximum ventilation rate (recharge mode):** 0.30 m³/s.
- **Thermal energy storage:** 6 to 10 kWh dependant on model.

System requirements:

- **Ventilation requirements:** connection to clean outside air source, inlet to be positioned away from sources of pollution and heating, eg. kitchen exhaust.
- **Inlet:** roof cowl or weather louvre. **Standard Grille Size:** 500 mm x 300 mm.
- **Filtration**: G4 bag filter.
- **Minimum supply duct size:** 500 mm x 150 mm.
- **Exhaust:** internal or external grille specified to suit.

Installation requirements:

- **Recommended minimum floor to ceiling height:** 2.6 m (Fascia).
- **Minimum ceiling void (if mounting within void):** 400 mm (Suspended Ceiling).
- **Weight:** 215 kg to 380 kg dependant on model.

Controls and user interface:

- Wall mounted user controls with room temperature, humidity and CO_2 sensors.
- Cool-phase control system including temperature and humidity sensors.
- Master/slave mode to control multiple units in a single zone.
- Optional connections to heating controls.
- Optional 'traffic light' indicator for windows.

Wiring requirements:

- Single phase mains with switched 5A fuse spur supply, positioned within 1 m from AHU footprint.
- CAT 5E network cable between unit and user interface.
- CAT 5E network cable between slave and master units.

Optional Connectivity:

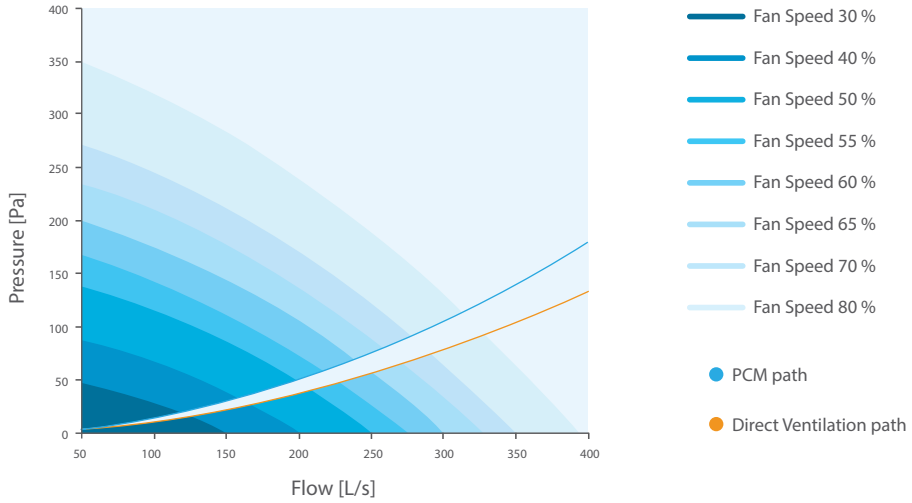
- The **BACnet** module allows a Cool-phase system to be installed on to a BACnet network. Each Cool-phase system has its own unique address on the BACnet network. Where multiple installations of Cool-phase units are located in one room, the Cool-phase units may be linked as Master/Slave configuration to form one system. In this instance the Master system will collate and display the BACnet information from the Slave systems.
- **The BACnet module requires** an RJ45 ethernet connection (by others) from the central BACnet gateway to the AHU of the Cool-phase unit.
- **The following information is available for display over BACnet:** Room temperature, Room CO_2 level, Cool-phase operation mode, External/Duct air temperature, Fault indication, Cool-phase charge status and Filter status.

PERFORMANCE

Fan Power

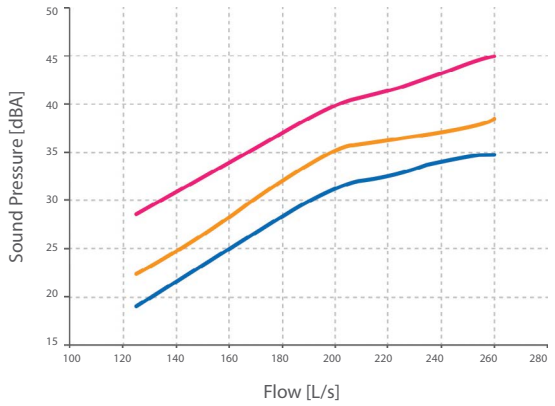
Flowrate [L/s]	SFP	Power Consumption	Operation
100	0.075	7 W	**Normal Operation:** During normal operation the system operates at these flow rates to provide excellent internal air qualities.
125	0.086	11 W	
150	0.108	16 W	
175	0.130	23 W	**Boosted Operation:** The system can automatically increase the ventilation rates to provide additional fresh air when required and for compliance mode to meet 8 L/s per person for BB101 and 10 L/s per person for Guide A.
200	0.156	31 W	
225	0.190	43 W	
250	0.227	57 W	
260	0.238	62 W	
300	0.302	91 W	**Night Time Charge Operation:** The system automatically charges the PCM when required. During this mode we purge the space and cool the building fabric.

Fan Curve

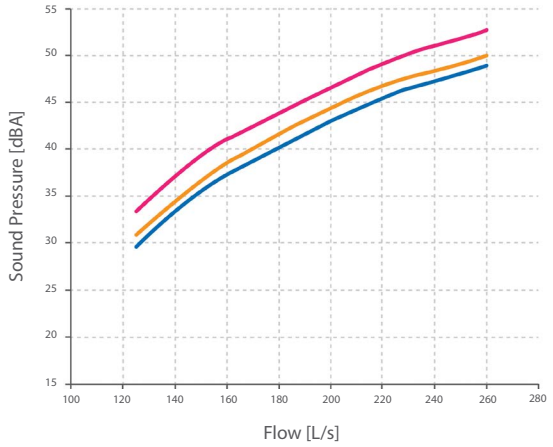


Acoustics

Cool-phase Suspended Ceiling



Cool-phase Fascia & Exposed Void



Retail
Office
Classroom

For further acoustics/performance data please contact Monodraught

BUILDING SIMULATION

NAVENSYS allows **Monodraught's Design Engineers** to apply climate data from almost any weather station in the world, scale it appropriately, and to input the type and geometry of a building and zone, the constituent parts of its envelope, fabric and the patterns of occupancy.

The results determine if statutory requirements or guidelines, such as Building Regulations or **BREEAM**, for ventilation rates, internal air temperatures and carbon dioxide concentrations are achieved.

All Monodraught design teams utilise **IES VE** to model complex building geometry.

To help architects and consultants deliver low maintenance, low energy designs within the built environment, Monodraught have collaborated with IES to produce the Cool-phase Performance Component.

For more information and a downloadable user guide please refer to the Building Simulation page at www.cool-phase.net

European Seasonal Energy Efficiency Ratio (ESEER)

The **European Seasonal Energy Efficiency Ratio (ESEER)** means the ratio of the total amount of cooling energy provided divided by the total energy input to the cooling plant (one or more cooling units) summed over a year. SEER may be estimated from the EER measured at partial load for the proposed building:

$SEER = a \times E_{25} + b \times E_{50} + c \times E_{75} + d \times E_{100}$

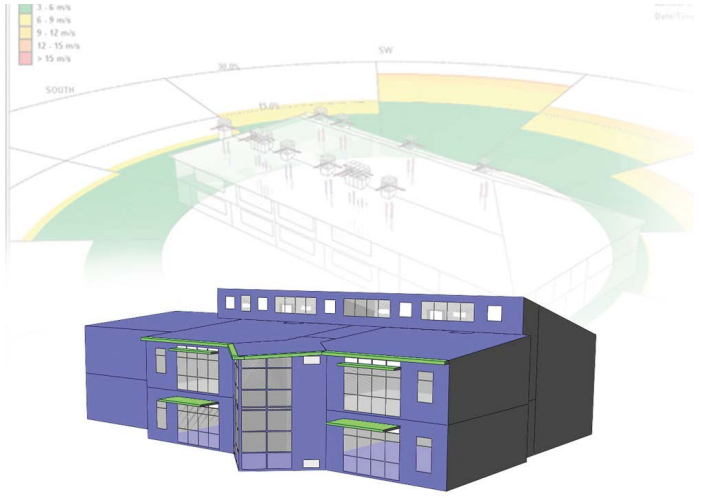
The ESEER value for cooling products is also used for part of the Building Regulations Part L calculations, and are used in the production of Energy Performance Certificates (EPC) for new buildings within the UK and the European Union; both as part of the European directive on the energy performance of buildings (EPBD).

BREEAM

Cool-phase low energy and low impact design fits well with building accreditation schemes such as BREEAM and LEED.

Within BREEAM 2011, Cool-phase can meet or assist in meeting the following criteria when correctly designed and specified within the building :- Hea 02 Indoor Air Quality (Criterion 1 Minimising sources of air pollution), Hea 03 Thermal Comfort, Ene 01 Reduction of Emissions, Ene 02 Energy Monitoring, Ene 04 Low and Zero Carbon Technologies (Criterion 3 Free Cooling), Man 04 Building User Guide and Man 05 Life Cycle Costs and Service Life Planning.

For more information on BREEAM and LEED and how Cool-phase meets these criteria a fact sheet is available from www.cool-phase.net



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