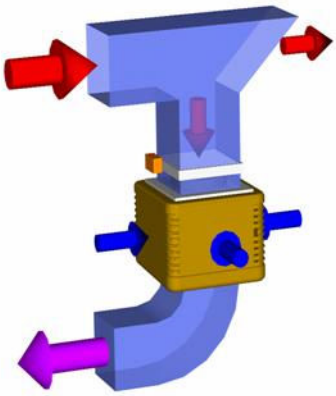
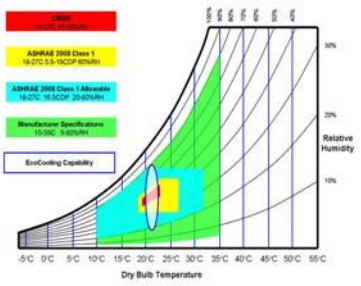
Energy Efficient Server Room and Data Centre Cooling



Computer Room Evaporative Cooler

EcoCooling



EcoCooling CREC
Computer Room Evaporative Cooler

Reduce your cooling costs by over 90%

Did you know?

An EcoCooling CREC can provide compliant cooling conditions for your server room or data centre using 90% less energy than a Computer Room Air Conditioner (CRAC).

How does it work?

A ventilation system is carefully sized to provide a constant flow of fresh air to the IT equipment. During cool periods a patented attemperation system raises the air temperature. During warm and hot periods evaporative cooling is used to cool the air.

Why is this possible?

Manufacturers of servers have increased the operating range of both temperature and relative humidity. The ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) standards have also widened to accommodate the latest equipment. The close control, particularly of relative humidity, required by main frame computers, and paper or magnetic media systems is no longer required.

How has it changed?

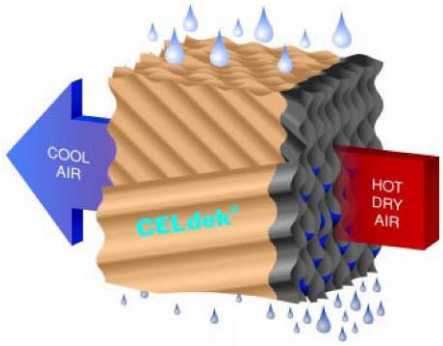
Modern IT equipment is far more robust than older equipment. For example most manufacturers specify a 10°C to 35°C operating temperature. Relative Humidity is not so critical now tape to tape and paper systems are no longer used. This has been exploited to a limited degree with the use of air economizers or free air cooling systems. Until now these have still required the back-up of a refrigeration system to accommodate the times of the year when ambient temperatures exceed 25°C.

What is an EcoCooling CREC?

EcoCooling have been working with data centres and server room equipment manufacturers to develop a modular CREC computer room evaporative cooling system which can be used for new projects or retrofitted to existing facilities. Comprehensive process controls maintain compliant temperatures together with all of the connectivity required for the secure and safe operation of the total package.

The Low Cost, Low Carbon impact alternative to air conditioning

How Evaporative Cooling is Applied in an EcoCooler CREC

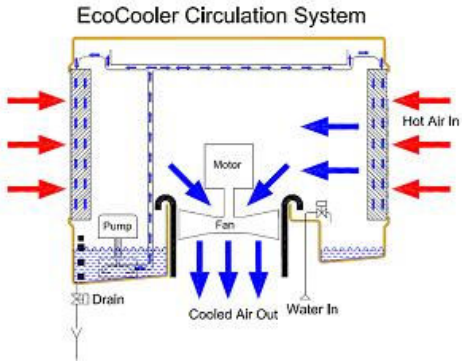


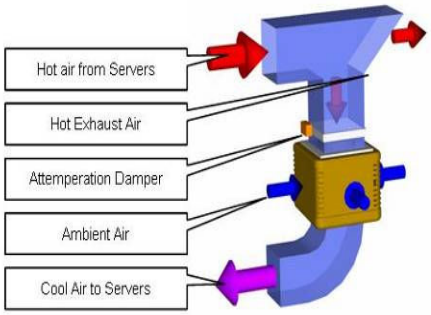
Evaporative Cooling

Air is hygroscopic. When it is put in contact with water evaporation occurs and the moisture content of the air increases. The energy required to change the state of the water from a liquid to a gas comes from the sensible heat of the air which cools as a result. Evaporative cooling is also known as adiabatic cooling.

The Operation of an EcoCooler

The EcoCooler is constructed of corrosion proof polymer and contains an axial fan. When cooling the EcoCooler is automatically filled with water and a centrifugal pump circulates water over the pads. The fan draws the air across the pads to create the cooling. A unique process control system linked to a four level water probe maintains hygienic and safe operation.



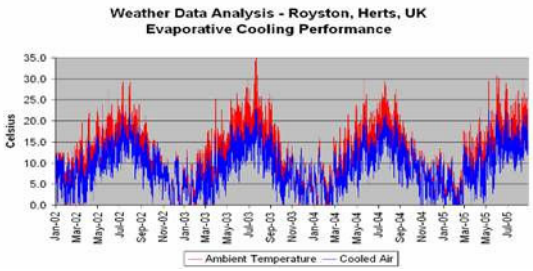


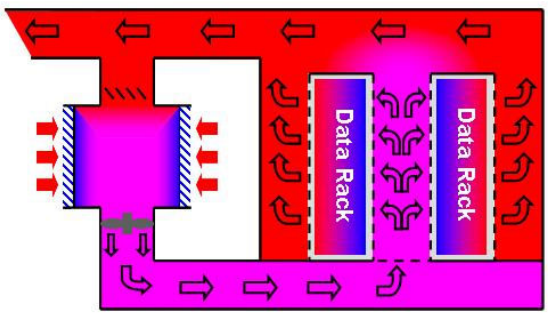
CREC Operation

A patented attemperation system maintains a constant temperature supply to the IT equipment. The hot air is mixed with ambient, or evaporatively cooled air, using a single damper. When the external temperature rises over a set point the evaporative cooling is enabled to ensure either the typical target air supply temperature of 21C is achieved or slightly over during the very hottest periods. A standard EcoCooler CREC module will supply ~3 cubic meters per second which can support over 35kW of IT load.

Cooling Effectiveness

The EcoCooling CREC is designed to give a saturation efficiency of 90%. This results in a maximum air supply temperature of 23C. This applies during extreme weather conditions such as those experienced in 2003 when the ambient temperature approached 35C.

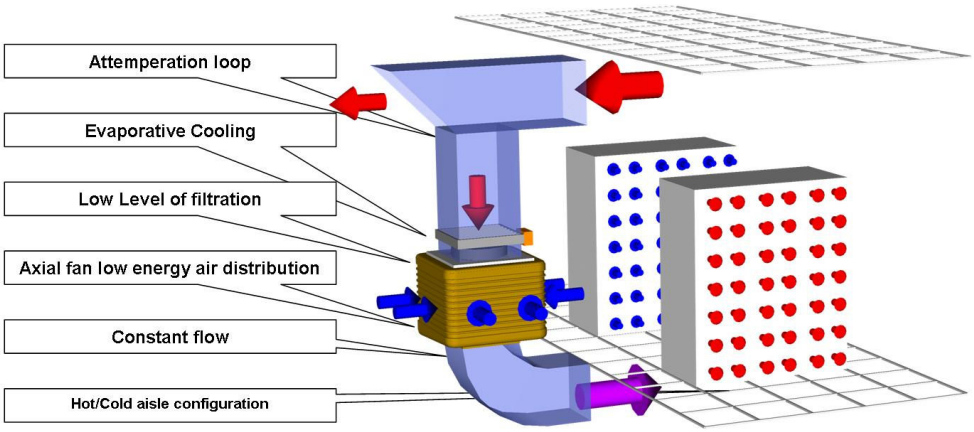




CREC Typical Installation

CREC's are normally installed external to the building. The air flow rate to the raised floor is fixed and is determined by the IT equipment. A standard 600mm air supply grille requires a supply pressure of ~20Pa which gives 500l/s of air: - This will support approximately 6kW of load. For larger systems a patented pressure control system accommodates variation in flow dynamics. Best practice recommends hot and cold aisle configuration with aisle containment being preferred but not essential for satisfactory operation.

CREC Design Principles



Hot/Cold aisle configuration

- Best practice dictates the arrangement of racks to give hot and cold aisles to prevent crossover of hot air into the server air intakes.
- Other practices including blanking plates, careful cable routing to prevent obstructions to air flow in the raised floor and in the rack, either hot or cold aisle containment should ideally be implemented.

Attemperation loop

- For the majority of the time the ambient air is actually too cold. The attemperation loop mixes hot exhaust air with the ambient air to produce the desired temperature of air flow.
- The EcoCooling CREC has a patented attemperation system which uses only one damper and avoids the need for an external air mixing box typically found in air handling systems.

Evaporative cooling

- Whilst many fresh air or free cooling systems are available they all require the support of a refrigeration based cooling system when the ambient temperature rises.
- The EcoCooling CREC removes all need for refrigeration as the evaporative cooling element can maintain compliant conditions throughout the year.

Low level of filtration

- Modern IT equipment with sealed bearings and closed drives does not require fine filtration.
- The filter media in an EcoCooling CREC provides dust free conditions.

Axial fan low energy air distribution

- A typical centrifugal fan, such as that found in CRAC's, consumes three times the power of an axial fan for a given flow rate.
- A CREC system is designed to be a low pressure, high flow rate system which provides the correct volume of air to the IT equipment at the lowest energy use. Modern IT equipment with sealed bearings and closed drives does not require fine filtration.

Constant flow

- IT equipment requires a constant flow of air at the correct conditions. The EcoCooling CREC forms part of a complete system using either raised floors or other forms of air distribution to fulfil this need.
- Hot spots on the tops of racks are commonly caused by insufficient air flow. A combination of CRAC's with undersized air supply fans or blocked filters, the wrong number floor tiles and their incorrect positioning and air flow obstructions all contribute to this. If there is insufficient air flow problems will arise regardless of the cooling method.

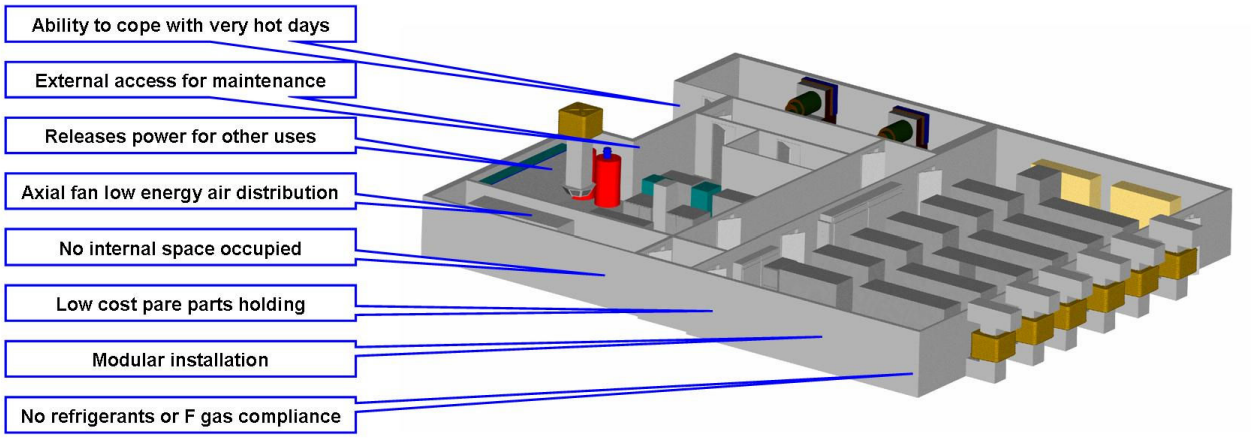
How is the air flow rate calculated?

The ventilation fan in a modern server is designed with an air flow rate which reflects its heat load and the temperature resistance of its components. The temperature difference between the air in and the air out is known as the ΔT (delta T). Most servers are designed with a ΔT of 10C although some blade servers will approach 15C. The thermodynamic equation $Q=mC_p\Delta T$ is then used to calculate the air flow rate. As an example a server room of 100kW of 10C ΔT servers requires approximately 8.5 cubic metres per second of air.

How many CREC's are required?

A standard EcoCooler CREC produces 3 cubic metres per second of air in a normal installation. The number of CREC's required is found by dividing the total flow required by the CREC flow rate. Normal rules of redundancy or resilience are then applied.

CREC Operation



What are the savings?

The performance of refrigeration based CRAC's varies according to the design and their utilisation. A refrigeration based CRAC uses electricity for the refrigeration circuit, the air distribution fan, the condenser fan and a small amount for the control systems.

The most efficient CRAC's, with variable speed fans and the facility for free cooling, will have a Coefficient of Performance (CoP) of 3.7. This means that 3.7kW of cooling will be produced for every 1kW of electricity consumed. This does not include the cost of humidification. ***An EcoCooler CREC consumes 1.5kW of electricity to support a load of 35kW. This is equivalent to a CoP of 23.8 giving a saving of 85%.***

In practice most CRAC's are not fitted with the energy saving options and have a CoP of 2. In many cases this is not achieved and the true operating CoP is closer to 1 meaning that the same amount of energy is put into the cooling system as is taken by the IT equipment. The table below shows the typical savings for a 100kW server room using various cooling solutions based on 8p/kWhr and 0.53702 kg/CO_2 per kWhr.

	EcoCooler	CRAC with free cooling	Standard CRAC	Typical CRAC
CoP	23.8	3.7	2.0	1.0
Power Consumed *kW*	4.2	27.0	50.0	100.0
Annual Electricity Use *kWhr*	36,792	236,757	438,000	876,000
Electricity Saving *kWhr*	n/a	199,965	401,208	839,208
Electricity Cost Saving	n/a	£15,997	£32,097	£67,137
Carbon Saving *Tonnes*	n/a	107	215	450

Note that the water usage would be approximately 160 cubic meters per year for a 100kW EcoCooling CREC system.

EcoCooling

- Can provide ASHRAE and manufacturer compliant conditions.
- Uses low energy axial fan technology.
- Hot and cold aisle arrangements are ideal for EcoCooling systems.
- Small modules offer low capital cost solutions to differing tiered reliability requirements.
- Energy use is typically 5% of installed capacity dependent upon ambient conditions.
- UPS is normally capable of maintaining supply to EcoCoolers. In case of power outage cooling recovery is practically instantaneous

CRAC's

- Can provide very close control of temperature and humidity.
- Typically uses energy intensive centrifugal fans.
- In many cases hot spots are present due to poor air distribution.
- CRAC's are normally large duty items resulting in expensive N+1 and 2N solutions.
- Energy use varies from 33% to 100% of equipment installed capacity.
- Cannot normally be accommodated by UPS. Expensive equipment is required for rapid recovery from power outage.

Control

The control philosophy of an EcoCooling CREC is based on a cascade of operations dependent upon the outside temperature. Where CRAC's are available these can be enabled automatically at specified conditions or situations if required.

Installations involving multiple CREC's require integrated solutions which EcoCooling can provide.
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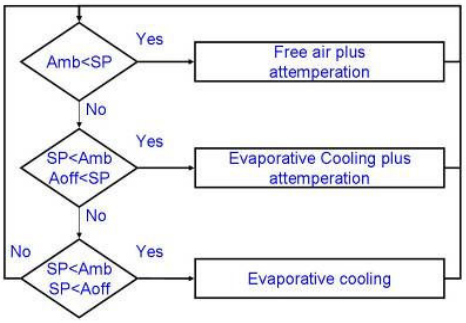
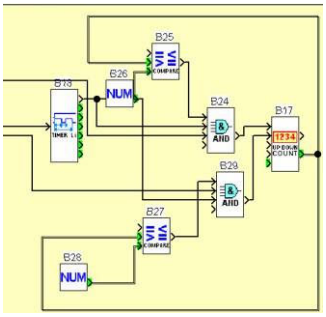


A PLC is used to control all parameters and monitor performance. This includes group control of CREC's and links to fire systems. An Ethernet protocol TCP Modbus facility is available for integration with other systems.



Funding

EcoCooling CREC's qualify for funding from the Carbon Trust Interest Free Loan Scheme and the Salix Finance Scheme.

Carbon Trust Interest Free Loan Scheme

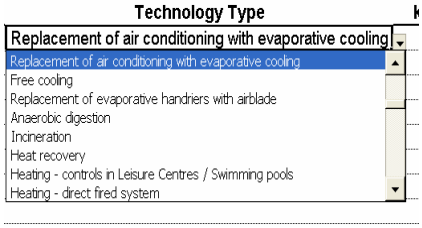
Unsecured Interest Free Loans of up to £500,000 are available for qualifying companies from the Carbon Trust to fund energy saving projects. Please refer to www.carbontrust.co.uk for further details. In principle SME's and larger companies not falling into the Carbon Reduction Commitment scheme can apply. Full support is given by EcoCooling, its consultants and installers in this application process which normally takes less than 3 weeks from submission to a loan agreement being made

Salix Finance for the Public Sector

Salix delivers interest free funding to accelerate investment in energy efficiency technologies across the UK public sector.

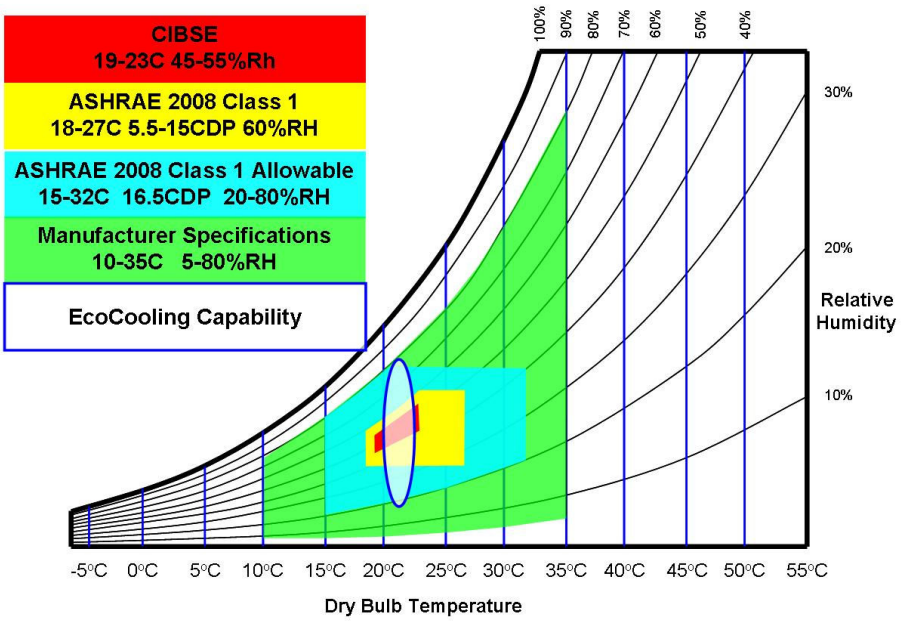
The Salix Finance Scheme objective is to enable NHS trusts, universities, local authorities, central government and other public sector bodies to improve energy efficiency by providing loans and ring-fence conditional grants to make effective, long-lasting carbon saving projects happen in the public sector.
Salix has public funding from the Carbon Trust.

The replacement of air conditioning with evaporative cooling has a persistence factor of 15.84 in the Salix Compliance Tool V21.
EcoCooling provides a cost comparison model to calculate the data to be inputted to the compliance tool.



Environmental Standards for IT Equipment

Temperature, humidity and contamination must all be considered when designing a cooling system for a server room or data centre. The diagram below shows recognised standards, the typical manufacturer environmental specification and the performance expected from an EcoCooling CREC in a temperate climate as found in Northern Europe.



What is the temperature range?

Most modern servers are designed to operate at between 10C and 35C. Care should be taken when operating over 25C as most server ventilation fans are designed to increase in speed to accommodate the higher air intake temperatures. This leads to increased energy use of the fan and potential noise problems.

What is the humidity range?

Whilst Relative Humidity (RH) is the most recognised measurement of humidity, modern standards also refer to the Dew Point which is a measure of Specific Humidity (SH). Historically the key issues associated with humidity are static electricity and the effects of the content and rate of change of change of moisture in the air on paper and magnetic tape systems. Modern equipment with correctly earthed racks, components and raised floors along with good maintenance procedures has rendered close control of humidity redundant. There is little data to support the business case for the use of humidification in the prevention of equipment failure. The majority of the telecoms industry uses no humidification.

What about dust and external contamination?

Modern IT equipment has closed drives and sealed bearings. The Intel Proof of Concept Study in a high density data centre using fresh air with no filtration showed no significant increase in failure rate despite the servers being completely covered in dust. [http://communities.intel.com/docs/DOC-1840]. The cooling pads and insect screens fitted to an EcoCooling CREC system result in no visible dust.

Care must be shown if air intakes can bring in carbon deposits such as those found in engine exhaust fumes, particularly diesel engines, and smoke from burning carbon fuels.

Some examples of specified operating conditions.

Manufacturer	Model	Temp C	Humidity
IBM	eServer xSeries 225	Min 10 Max 30	8 - 80%
Dell	PowerEdge 4400	Min 10 Max 35	8% to 80% non-condensing
Cisco	MXE 300	Min 10 Max 35	10% to 90% non-condensing
HP	server rx4610	Min 5 Max 35	20% to 80% non-condensing

Frequently Asked Questions

How does a CREC manage very hot days?

- In a temperate climate the relative humidity falls as the temperature rises. August 2003 saw record temperatures in Britain exceeding 35C with a relative humidity of 21%. It is this relationship which allows an EcoCooling CREC to maintain cold aisle temperatures of 21C for over 99% of the time and never go above 23C.

How much maintenance is required?

- It is normal to maintain an EcoCooling CREC every 6 months. This is a simple operation of cleaning and validation of settings. Since the CREC's are normally external to the building there is no requirement for maintenance engineers to enter the server room or data centre. EcoCooling has an approved list of certified service contractors.

How long do the filter pads last?

- Filter pads last from 3 to 5 years.

Can you catch Legionnaires' disease from an EcoCooling Evaporative Cooler?

- No, primarily because the circulating water is less than 20C and no droplets are formed. An EcoCooler is classed as low risk (the same as a hot and cold water supply system). A legionella risk assessment is produced as part of the commissioning process.

Is the water re-circulated?

- Yes, the water is re-circulated until the evaporation has concentrated it to its scaling point or when the cooling is turned off and the cooler automatically drains.

What happens in freezing conditions?

- It is normal to completely drain the water systems as part of the autumn maintenance and so eliminate any risk of frost damage.

What is the warranty?

- The EcoCooling CREC has a parts only warranty of 2 years.

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Do the pads clean the air?

- Yes, the pad will filter out larger particles such as dust or pollen. Insect screens are also fitted as standard.

Is the EcoCooling CREC suitable for all global locations and climates?

- No, it is not suitable for tropical climates where the wet bulb temperature of the ambient air can exceed 25C. EcoCooling can provide specific advice on performance for any location in the world.

Is the EcoCooling CREC suitable for all IT equipment?

- Older equipment such as main frame computers and paper media systems require close control of relative humidity and so evaporative cooling cannot be used.

What is the availability of spare parts?

- EcoCooling holds a complete inventory of spare parts in the UK.

Is the EcoCooling CREC CE marked?

- All EcoCooling products are CE marked using UK based approved testing and assessment facilities.

What other applications can EcoCoolers are used for?

- EcoCooling is ideal for the cooling of UPS rooms and other plant rooms. Air conditioning systems in offices, call centres and IT training facilities can all be replaced with EcoCooling evaporative cooling systems. Fresh air systems have many benefits in these applications beyond reduction of cost and environmental impact.

EcoCooling Contact Information:

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