



# Cooling of Supply Air Using Direct Evaporative Cooling

Understanding performance across the UK climate

The performance of direct evaporative cooling is directly determined by the relative humidity of the incoming air. This paper explains the science, the regional variation across the UK, and what it means for your facility.

**11-13 °C**

**Indicative cooling at  
20-30% RH**

Low humidity allows greater evaporation potential, resulting in a higher cooling effect

**4-6 °C**

**Indicative cooling at  
60-70% RH**

Higher humidity reduces evaporation potential, resulting in a lower cooling effect

These figures are indicative and based on 30 °C outside air temperature. Actual performance will vary based on site conditions, building design, heat load and ventilation strategy.



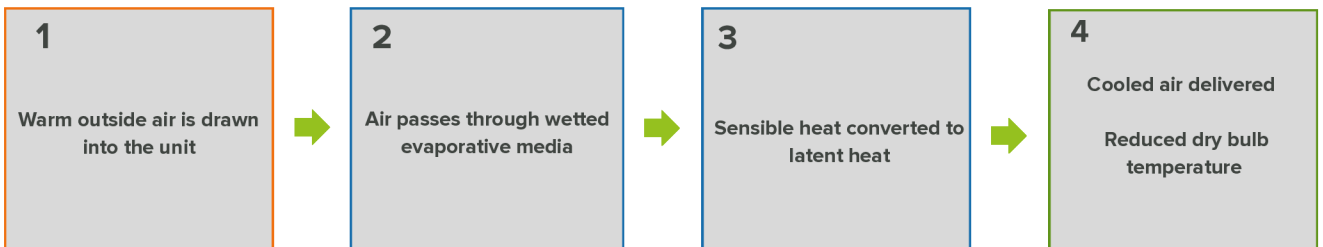
# The Principle of Direct Evaporative Cooling

A direct evaporative cooler works by drawing warm outside air through wet evaporative pads. As water evaporates into the airstream, sensible heat is converted into latent heat, reducing the dry bulb temperature of the supply air delivered into the space.

## THE KEY PRINCIPLE

The drier the air, the greater the evaporation potential, and therefore the greater the cooling effect.

## THE EVAPORATION PROCESS



## RELATIVE HUMIDITY AND COOLING PERFORMANCE

### Understanding Wet Bulb Temperature

Wet bulb temperature is one of the key factors that determines evaporative cooling performance.

As water evaporates into the airstream, sensible heat is converted into latent heat, reducing the dry bulb temperature. The amount of cooling achievable depends on how much additional moisture the air can accept.

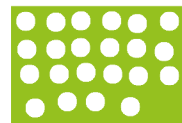
Lower relative humidity provides greater evaporation potential and therefore greater temperature reduction. As humidity increases, the air becomes closer to saturation, reducing the available cooling effect.

### Why Cooling Performance Reduces

Air can only absorb a finite amount of moisture before it reaches saturation point. Once saturated, evaporation stops — and therefore cooling stops.



Unsaturated air - able to absorb more moisture



Saturated air - cooling performance reduced



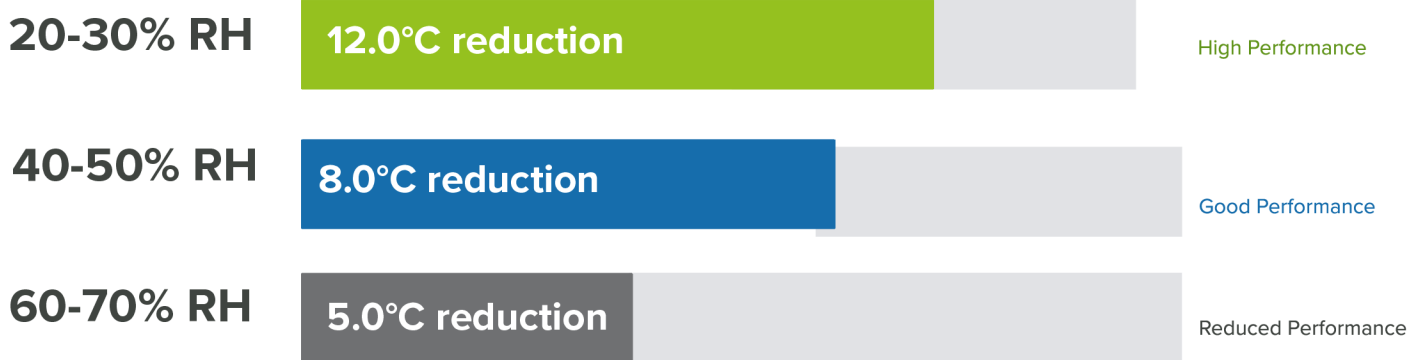
This is why location matters.

A direct evaporative cooler installed in England and one in Scotland could potentially perform very differently, even on the same day, at the same outside temperature, due to different humidity.

# Indicative Cooling Performance at 30°C Outside Air Temperature

The figures below show the indicative dry bulb temperature reduction achievable at different relative humidity levels, These conditions are representative of typical UK summer cooling assessments.

## INDICATIVE COOLING POTENTIAL BY HUMIDITY BAND



## FULL PERFORMANCE REFERENCE - 30°C OUTSIDE AIR TEMPERATURE

RH Band	Indicative Cooling Reduction	Discharge Temperature (at 30°C)	Rating
20% RH	~12.9°C	~17.1°C	High
30% RH	~10.9°C	~19.1°C	High
40% RH	~9.0°C	~21.0°C	Good
50% RH	~7.2°C	~22.8°C	Good
60% RH	~5.6°C	~24.4°C	Reduced
70% RH	~4.1°C	~25.9°C	Limited
80% RH	~2.6°C	~27.4°C	Minimal

Data source: TBS/TBSI Cooler Discharge Air Temperature Chart. All figures indicative at 30°C outside air temperature. Actual performance varies by site conditions, ventilation strategy, heat load and building design.

# UK Climate Context

## Typical summer relative humidity (RH) by region

Relative humidity is influenced by location, proximity to the coast, altitude and local weather patterns. These factors impact evaporative cooling potential and achievable temperature reduction.

<b>Eastern England (Inland)</b> Inland areas of eastern England typically experience lower humidity on warm, dry days	<b>40-55%</b>
<b>Wales &amp; Western Coastal Regions</b> Atlantic weather patterns typically create higher humidity levels	<b>45-60%</b>
<b>Midlands</b> Sits in the middle of the UK humidity range. Varies with weather patterns and season.	<b>50-65%</b>
<b>Northern England</b> higher humidity than the south. Inland variation remains	<b>55-70%</b>
<b>Scotland</b> Generally higher humidity, but lower typical summer temperatures mean less temperature reduction may be required to achieve suitable supply conditions.	<b>65-75%</b>



These regional patterns are a guide only. Your postcode is what matters



A CPA Controlled Air assessment uses verified local data for your specific site, not regional generalisations



The Met Office provides free location specific climate data including relative humidity averages.



### Different locations. Different Conditions. Different results

Understanding your local climate is the first step to predicting real world evaporative cooling performance.

# Air Movement and Perceived Cooling

Temperature reduction is only part of comfort cooling

Direct evaporative cooling delivers two measurable benefits — a reduction in dry bulb temperature and increased air movement.

In higher humidity conditions, where the achievable temperature reduction is more modest, effective airflow directly influences how occupants experience cooling within the space.

Airflow strategy and system design are therefore key considerations alongside discharge temperature, particularly across the higher humidity regions that characterise much of the UK climate.

## The Role of Air Velocity



### How it works

As air moves across the skin, heat transfer increases. Greater air movement enhances the perceived cooling effect, working alongside the temperature reduction delivered by the evaporative cooler.



### Why it matters

In industrial environments, where heat loads and working conditions vary, effective air movement plays an important role in supporting comfort alongside supply air temperature reduction.

## The Impact of Air Speed on Perceived Cooling

ASHRAE defines standard comfort zones at air speeds not greater than 0.2 m/s. However, the standard also recognises that elevated air speed allows the upper operative temperature limit to increase, meaning comfort can be achieved at higher temperatures when air movement is present.

Direct evaporative cooling typically delivers air at 1.0–1.5 m/s in the occupied zone; well above the conventional threshold, which extends the effective comfort envelope beyond what temperature figures alone would suggest.

## What this means in Practice

**4 - 5°C**

Dry bulb temperature reduction at higher humidity

**~3°C**

Additional perceived cooling from air movement at 1.5m/s

**7 - 8°C**

Total perceived cooling effect combined

Source: ASHRAE Standard 55 — Thermal Environmental Conditions for Human Occupancy. HSE Chart of Effective Temperature (Basic), Health and Safety Executive. Figures are indicative.

Occupant comfort is determined by the combination of temperature, humidity and air movement, not by any single factor in isolation. An engineered assessment considers all three..

# Beyond the Climate

Building conditions matter just as much

Even within the same region, two facilities can achieve very different results. Evaporative cooling performance is influenced by a range of internal factors that are as important as the outdoor conditions.

## Internal heat load



Heat from machinery, processes, lighting and occupancy directly increases the cooling demand. Higher loads require greater cooling capacity and airflow to achieve the same results.

## Roof and ceiling height



Taller buildings increase thermal stratification and require airflow to reach the occupied zone. Low roofed buildings need careful airflow strategies for even distribution.

## Ventilation rate



Air changes per hour determine how effectively cooled air replaces warm air within the space. Insufficient ventilation limits performance regardless of outdoor cooling potential.

## Infiltration



Open doors, loading bays and poorly sealed openings allow warm, humid outside air to enter the building directly.

## Unit positioning and airflow



The placement of evaporative units, the direction of discharge and the path of air through the building all affect how evenly cooled air is distributed. Poor positioning creates hot spots regardless of system capacity.

## Occupancy



People generate both heat and moisture. High occupancy increases thermal load and the moisture content of the air within the space. This reduces the effective cooling that can be achieved.



Two buildings in the same postcode can require two completely different solutions. This is why an engineered assessment, not a specification sheet is the right starting point.



Internal factors vary by building and operation. Performance depends on airflow strategy, design and control.

# Performance Starts with Your Site Conditions

Every facility is different. While climate data provides a useful starting point, real-world performance depends on how a cooling system is designed around the building, process and operating conditions.

## Key design consideration

The following considerations help determine how an evaporative cooling system should be designed for your specific environment.



### Cooling Requirement

Understanding the areas requiring cooling, operating conditions and objectives ensures the system is designed around the specific application.



### Airflow Design

Correct unit selection, positioning and airflow distribution ensure cooled air is delivered effectively throughout the space.



### Building Operation

Door openings, ventilation requirements and daily processes influence how the cooling system integrates into the working environment.



### Expected Performance

Climate data, building conditions and operational requirements are considered together to determine realistic cooling performance expectations.

Regional data and published performance figures provide context, but are not necessarily a substitute for site-specific analysis. Understanding how these variables interact at your site is an accurate starting point.



Every facility is different.

Speak to our CPA Controlled Air team about a site assessment. We'll help you understand your site conditions, expected performance and most effective cooling approach for your business.



### Engineering Expertise

Real-world experience across a wide range of industrial applications



### Honest Guidance

Practical advice based on verified data and site conditions, rather than theoretical benchmarks



### Long Term Support

Ongoing support to ensure your system continues to perform efficiently and reliably.



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CPA Controlled Air - white paper

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