

# Indirect/Direct Evaporative Cooling

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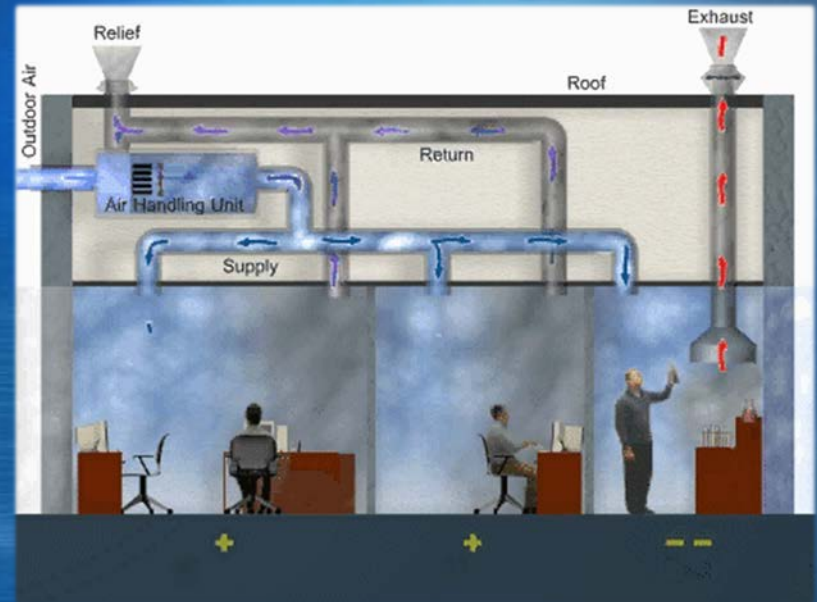
# Colorado's Climate

- The Colorado Front Range is **semi-arid, high-desert**.
  - 85<sup>o</sup> F average high temperatures in summer
  - Average (pm) humidity = 40%
- There are only approximately 15 days a year where humidity levels are too high for evaporative cooling.
- These 15 days typically occur when students are not in semester and staff office attire can be relaxed.
- Due to the above factors, outside air, indirect/direct evaporative cooling is an ideal mode of cooling providing 98% of the buildings cooling needs with reduced energy and a minimal carbon footprint.

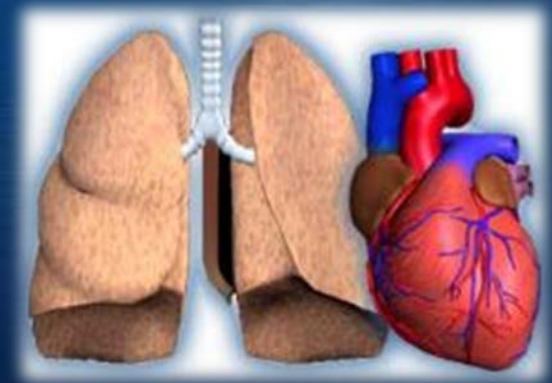


# A Typical Building's Cooling

- Chilled water is made from electrically/compressor driven equipment (similar to a/c in your car but on a larger scale).
- Chilled water is distributed to air distribution equipment which blows approximately 55 to 65 degree air throughout the building (like the fan in your car blowing the cold air onto you).

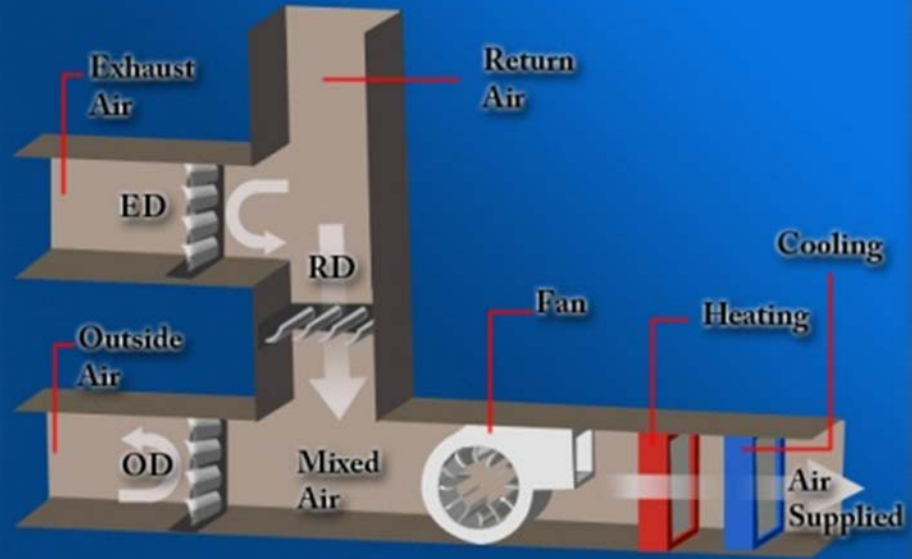


- The chiller is essentially the heart of the building pumping chilled water to the air handling units.
- The air handling units are essentially the lungs of the building breathing and cooling the body through respiration.

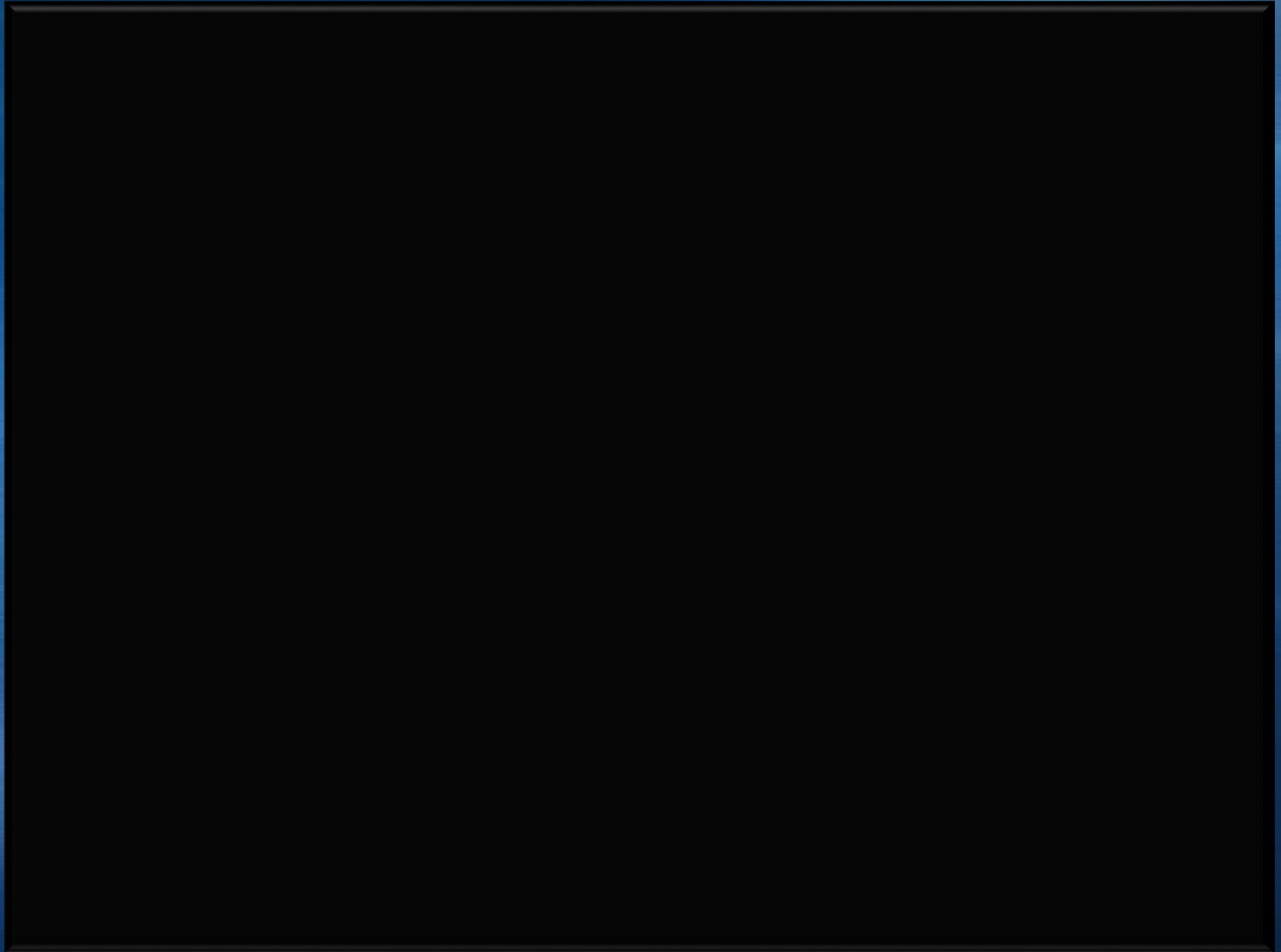


# Outside Air Economizer

- About 80% of the cooling season the air outside the building is sufficient to cool the building.
- We use the outside air to cool the building when 65°F or less.
- Similar to a person breathing heavily after exercise to cool their body, but not sweating yet.



# What is Evaporative Cooling?



# Evaporative Cooling

- **Evaporative cooling** works by employing water's capacity to absorb heat.
- Water absorbs the air's heat and vaporizes. When the water vaporizes the air is cooler.

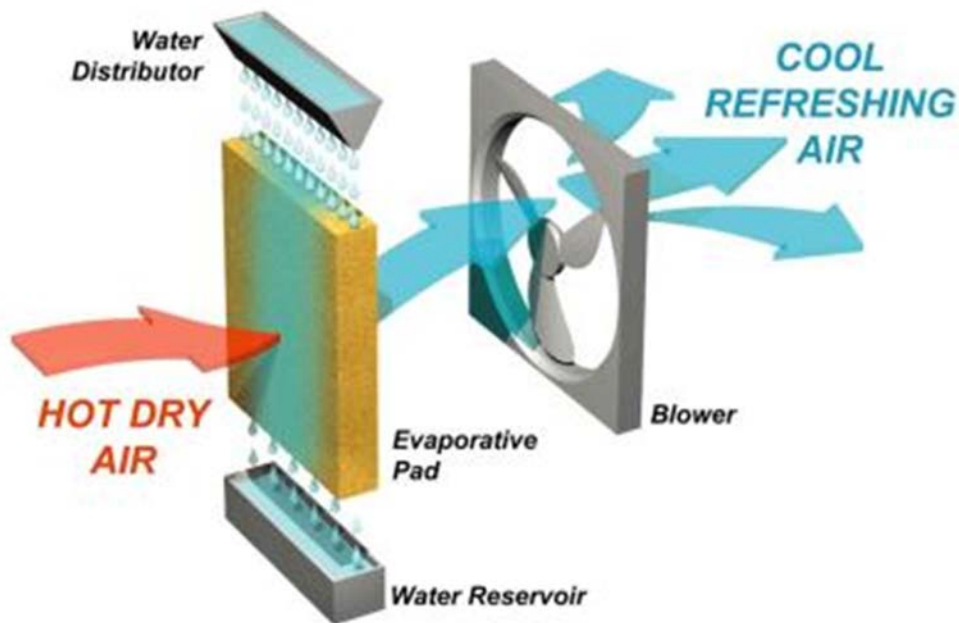


- Analogies:
  - Similar to a person jumping into a pool and cooled once out due to water evaporating on the skin.
- This will achieve the next 15% of the cooling for the building...

# Direct Evaporative Cooling

- **Direct evaporative** coolers blow hot, dry air through pads soaked in cold, circulating water.

## How **EVAPORATIVE COOLING** works



# Indirect Evaporative Cooling

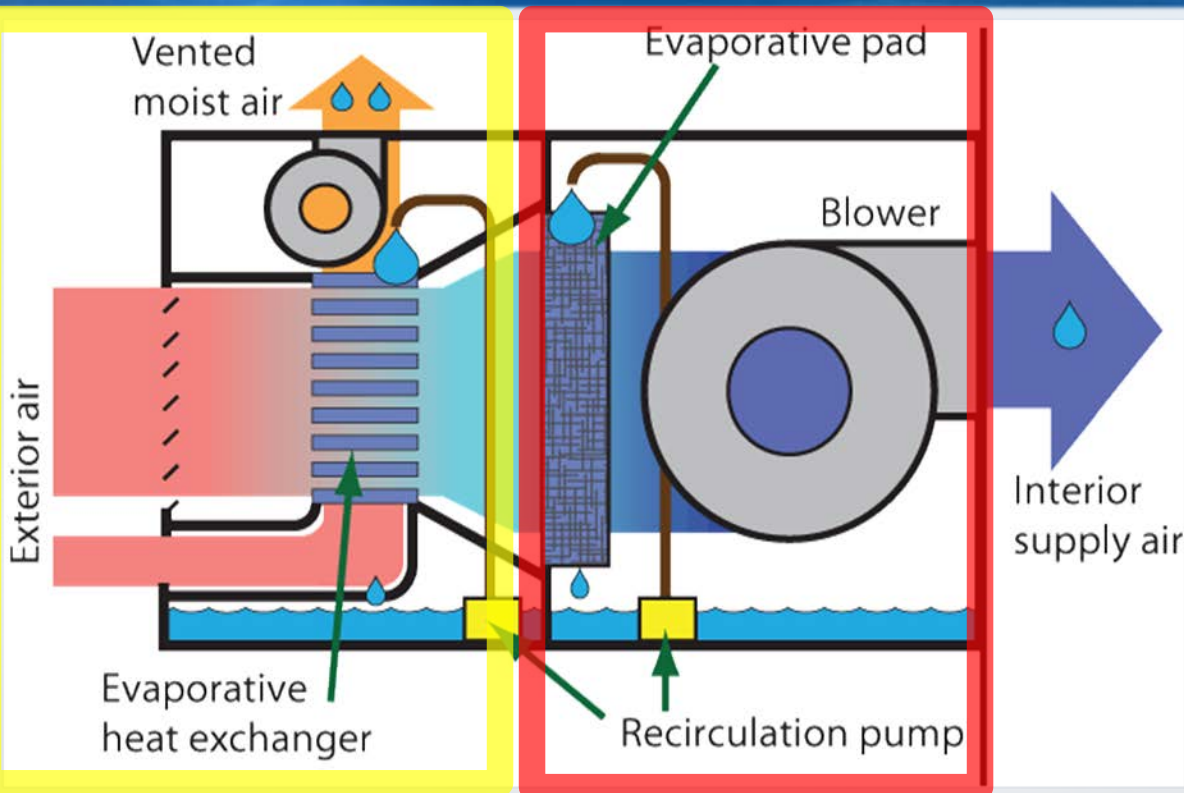
- With **indirect evaporative cooling** a heat exchanger is used to remove heat from the air.
  - The air and the water never touch, so there is **no increase in air moisture**.
- This mode is analogous to a overheated person drinking a cold beverage, the circulation system acts like the heat exchanger with the rest of the body.
- This achieves the last 3% of cooling for the building.





# Outside Air Economizer/Indirect/Direct Evaporative Cooling Staging

- Staging of outside air economizer Indirect/Direct evaporative cooling produces a comfortable environment.
  - First, warm air is pre-cooled **indirectly** without adding humidity (by passing inside a heat exchanger that is cooled by evaporation on the outside).
  - In the **direct** stage, the precooled air passes through a water-soaked pad and picks up humidity as it cools.



# Energy Savings

- Energy Savings
  - Annual estimated energy savings of **556,586 kWh per year.**
- Cost Savings
  - This equates to **at least \$30,000 per year or higher.**
- Tenant's Comfort
  - Tenants are comfortable 98% of the year. Occupants are not aware of how cooling is provided to the building. The remaining 2% of the cooling season or 15 days is accommodated by relaxed expectation of comfort and/or dress attire.



# Credits to Housing

- Considerations

- For a hospitality driven building, comfort and appearance are essential to the success of the building's activities.
- There is a risk of customers not returning if not satisfied with their visit.
- Indirect/Direct evaporative cooling was a risk for housing since it could not ensure comfort 100% of the year. However, Indirect/Direct cooling displaces more air and ensures better indoor air quality which is highly desirable for a comfortable hospitality environment.
- Our partners at housing deserved to be recognized for taking this risk.
- In the end C4C is a comfortable building where visitors have an enjoyable experience, there are a record number of meals served in the facility, and the building has reduced energy consumption and a minimal carbon footprint.