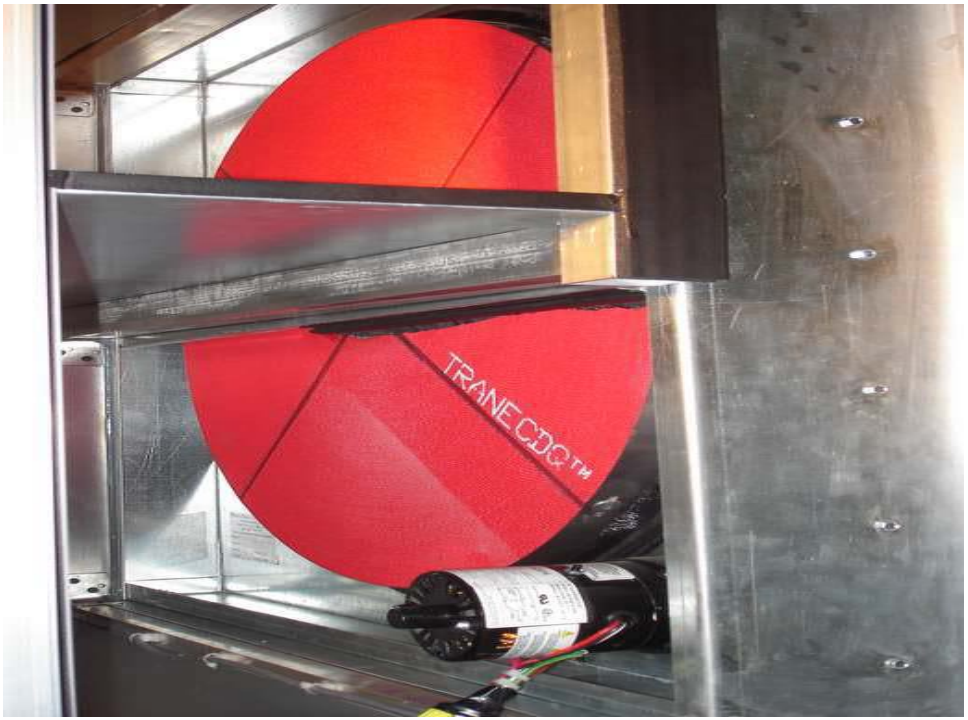
Innovative and energy efficient humidity control

Peter Lau

Application Manager

Ingersoll Rand

CDQ™ (Cool Dry Quiet) : Dehumidification Innovative and energy efficient humidity control



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CDQ™ (Cool Dry Quiet) Innovation

Frost & Sullivan
Recognizes Trane for Product Innovation of the Year for Its CDQ™ Desiccant Dehumidification System
27 Feb 06

R&D 100 Award in recognition of the year's 100 most significant technological innovations from R&D Magazine
Jun 2006

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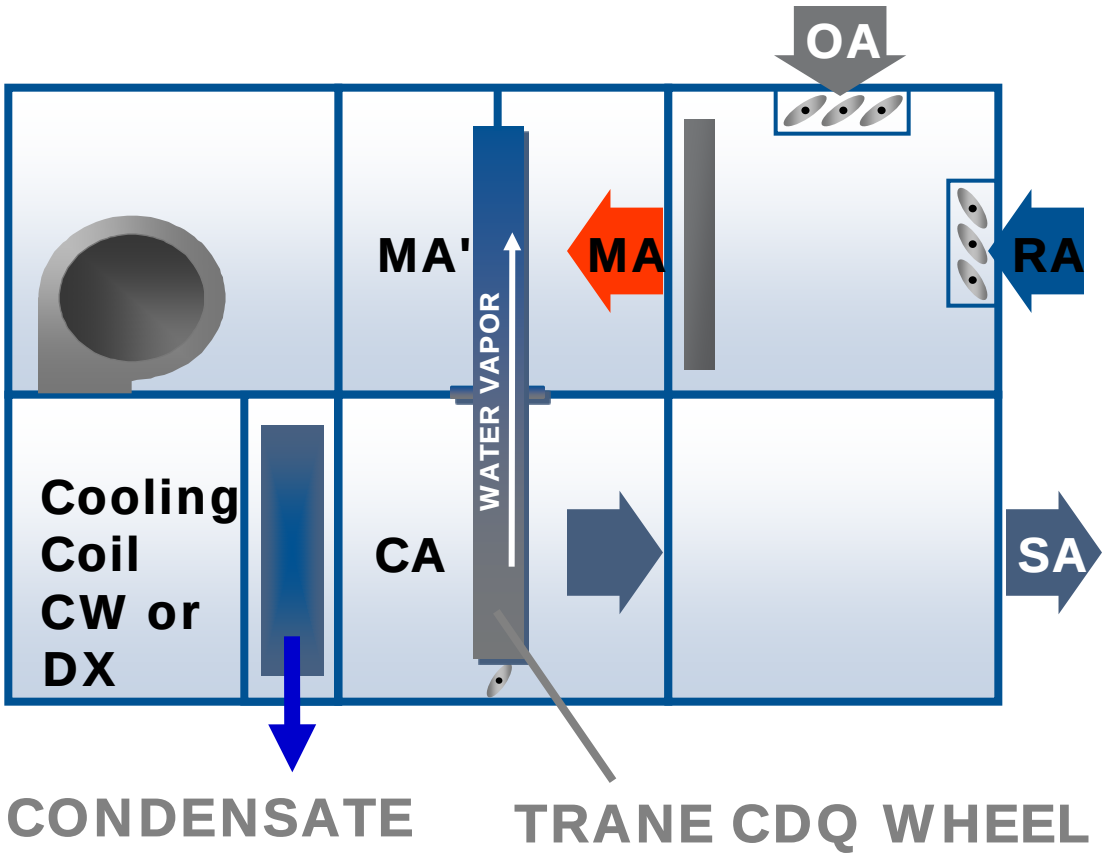
CDQ - What is it?



A “Series”
Desiccant wheel
used to
improve the
dehumidification
ability of
a cold coil

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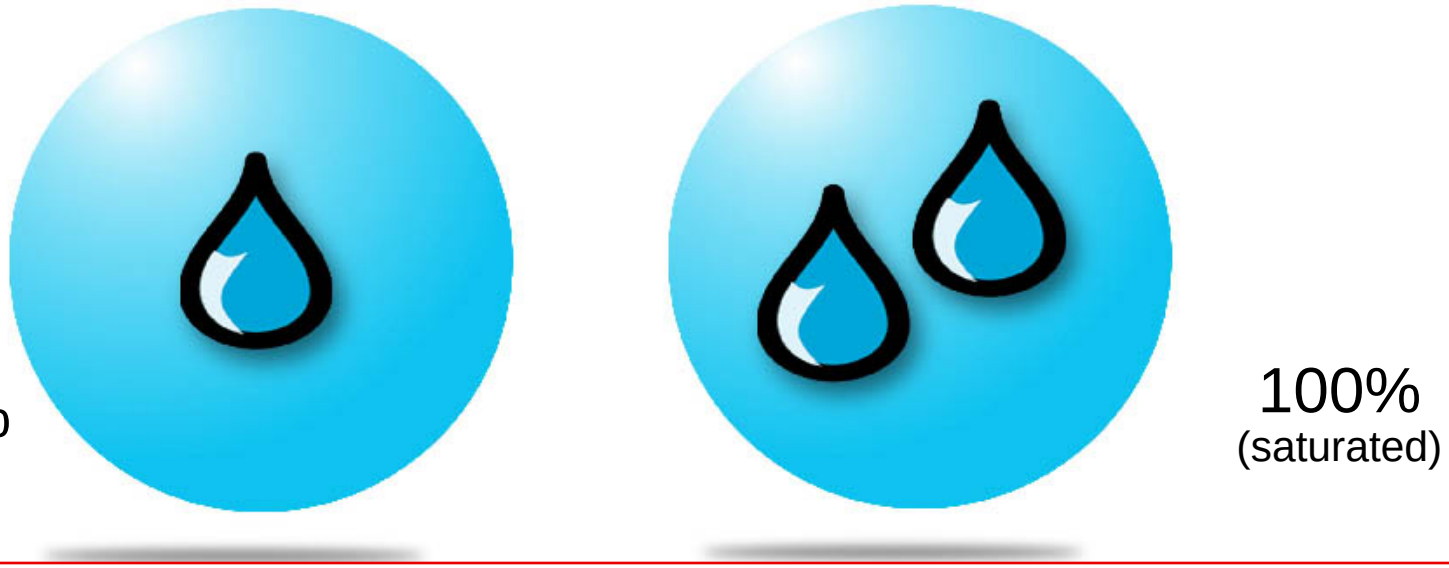
Relative Humidity
…describes the degree of saturation

$$\text{Relative Humidity} = \frac{\text{Amount of moisture that a given amount of air is holding}}{\text{Amount of moisture that a given amount of air can hold}}$$

Relative Humidity
…compares moisture content to saturation

Quiz: Why are you feeling more comfortable at lower Rh%(45%) then high humid (>80%)?



The process of sweating is your body's attempt to keep cool and maintain its current temperature. If the air is at 100-percent relative humidity, sweat will not evaporate into the air. As a result, we feel much hotter than the actual temperature when the relative humidity is high. If the relative humidity is low, we can feel much cooler than the actual temperature because our sweat evaporates easily, cooling us off

Humidity Ratio
…compares water vapor to dry air by weight

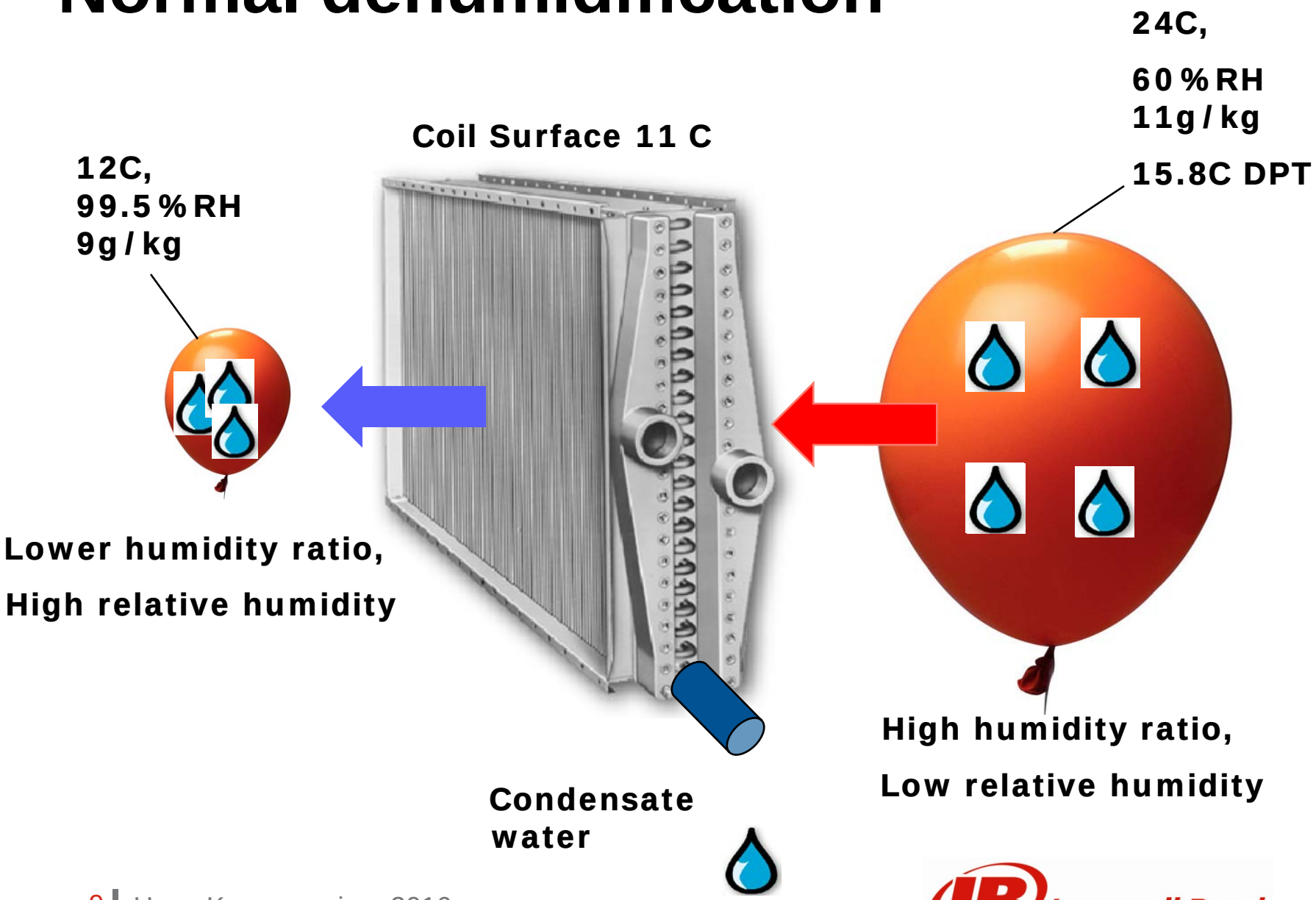
Unit:
Grain / Lb;
Lb / Lb;
Gram / kg

Condensation Occurs at Dew Point

Dew Point Temp means DB=WB= 100%RH Air is now 100% saturated

When the dewpoint approaches 75 degrees F (24 deg C) , most people can "feel" the thickness of the air as they breathe

Normal dehumidification



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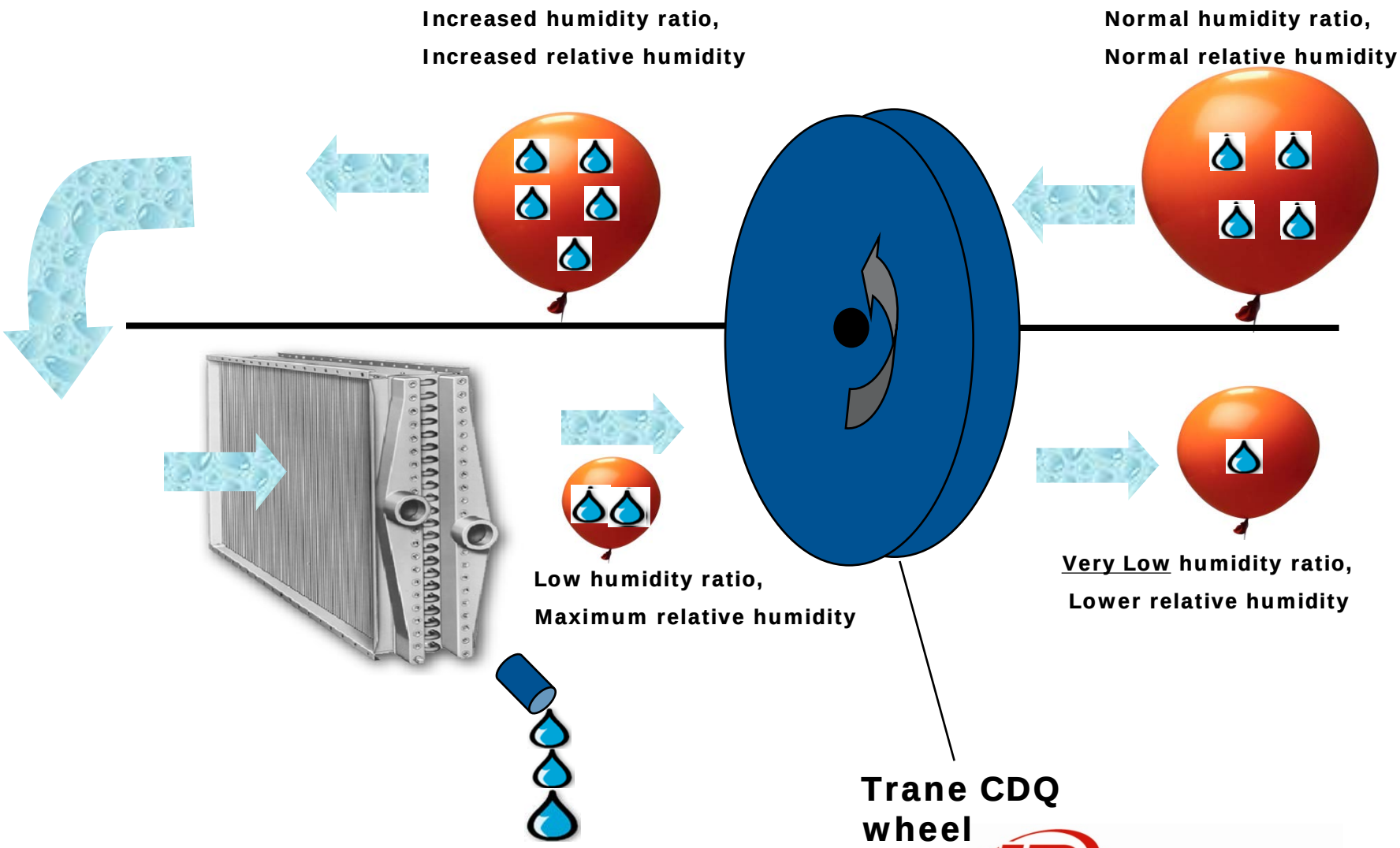
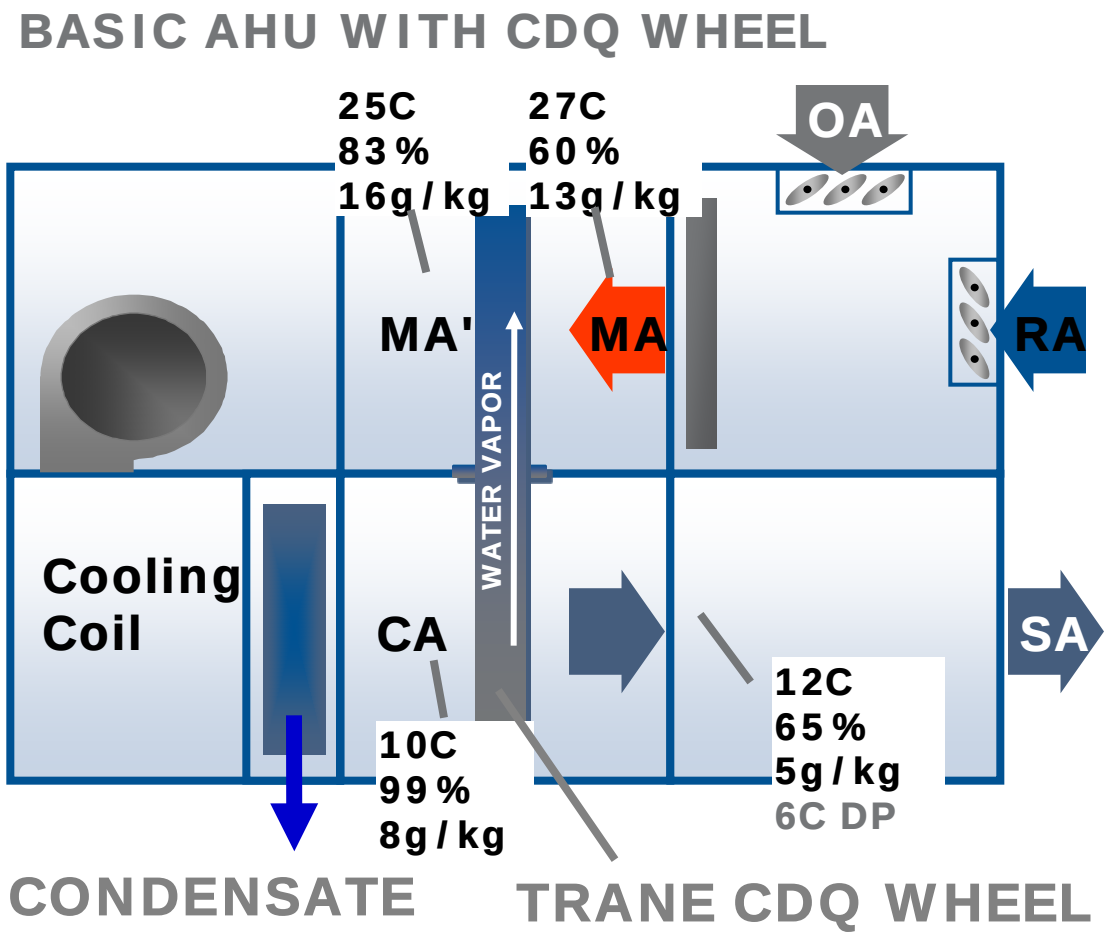
Innovative CDQ™ dehumidification



Innovative CDQ™ dehumidification



CDQ can produce supply air with dew point lower than the coil chilled water temperature or refrigerant suction temperature

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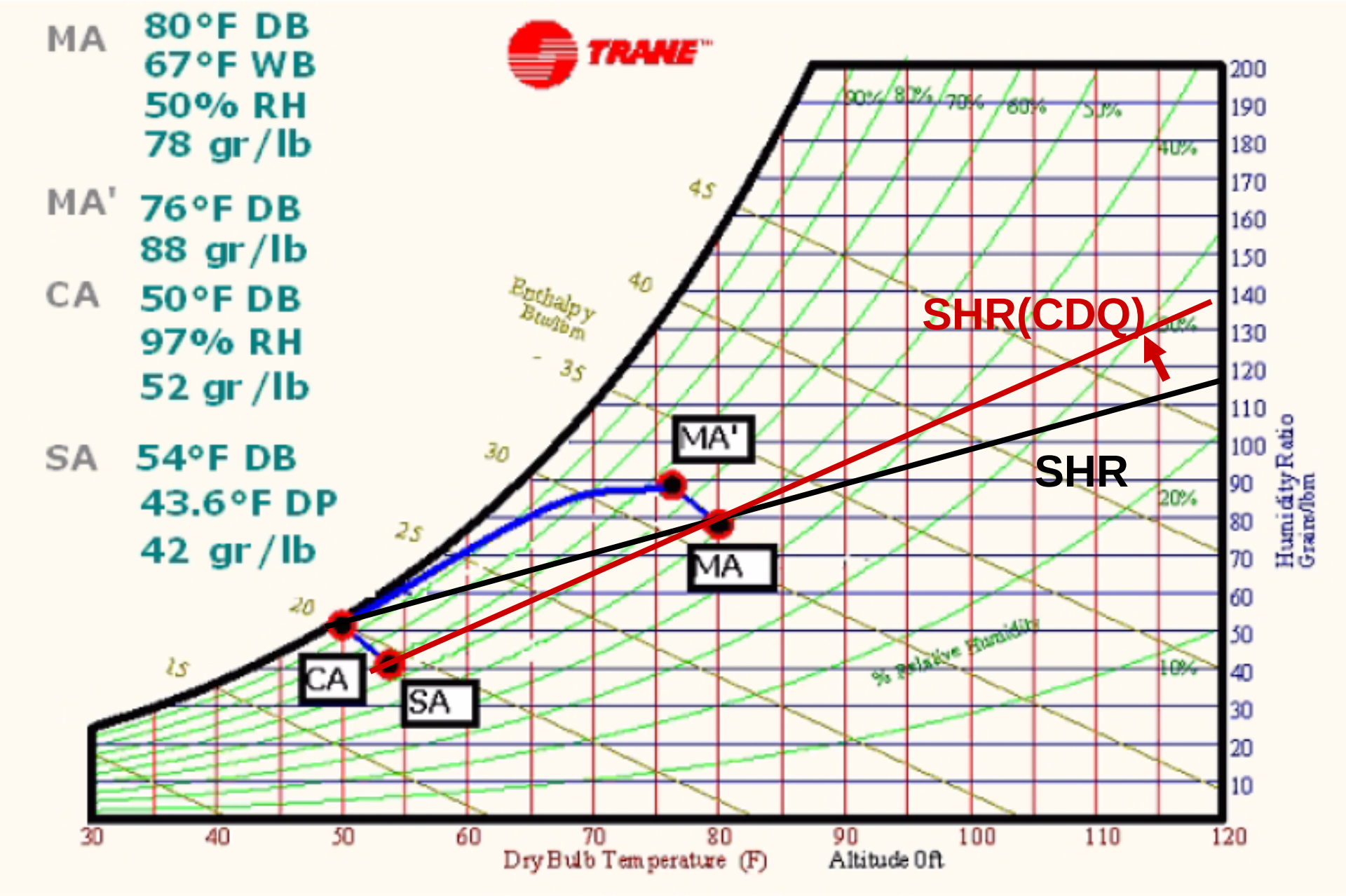
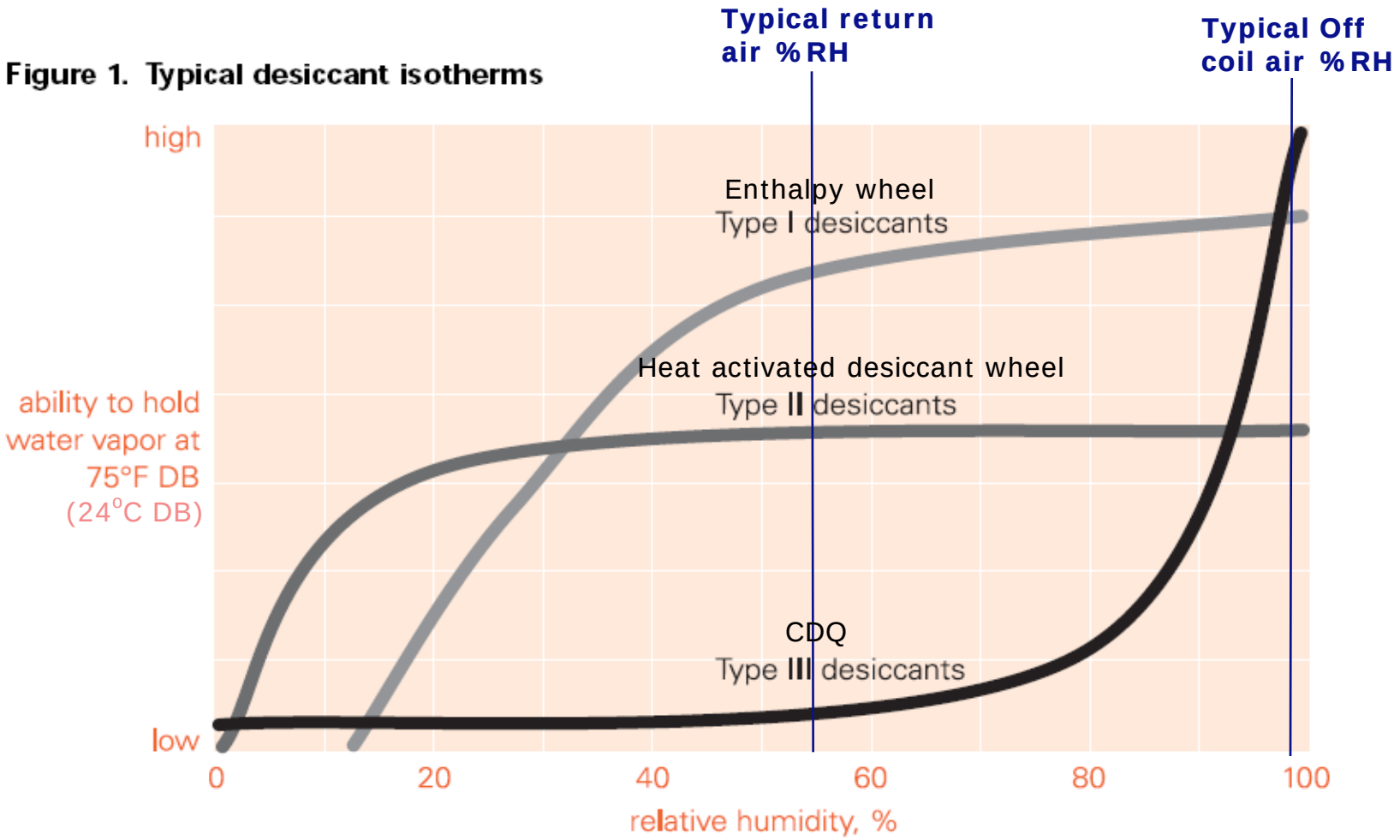
CDQ process: move along enthalpy line



CDQ desiccant – Specially developed



CDQ desiccant is “activated alumina”, type 3

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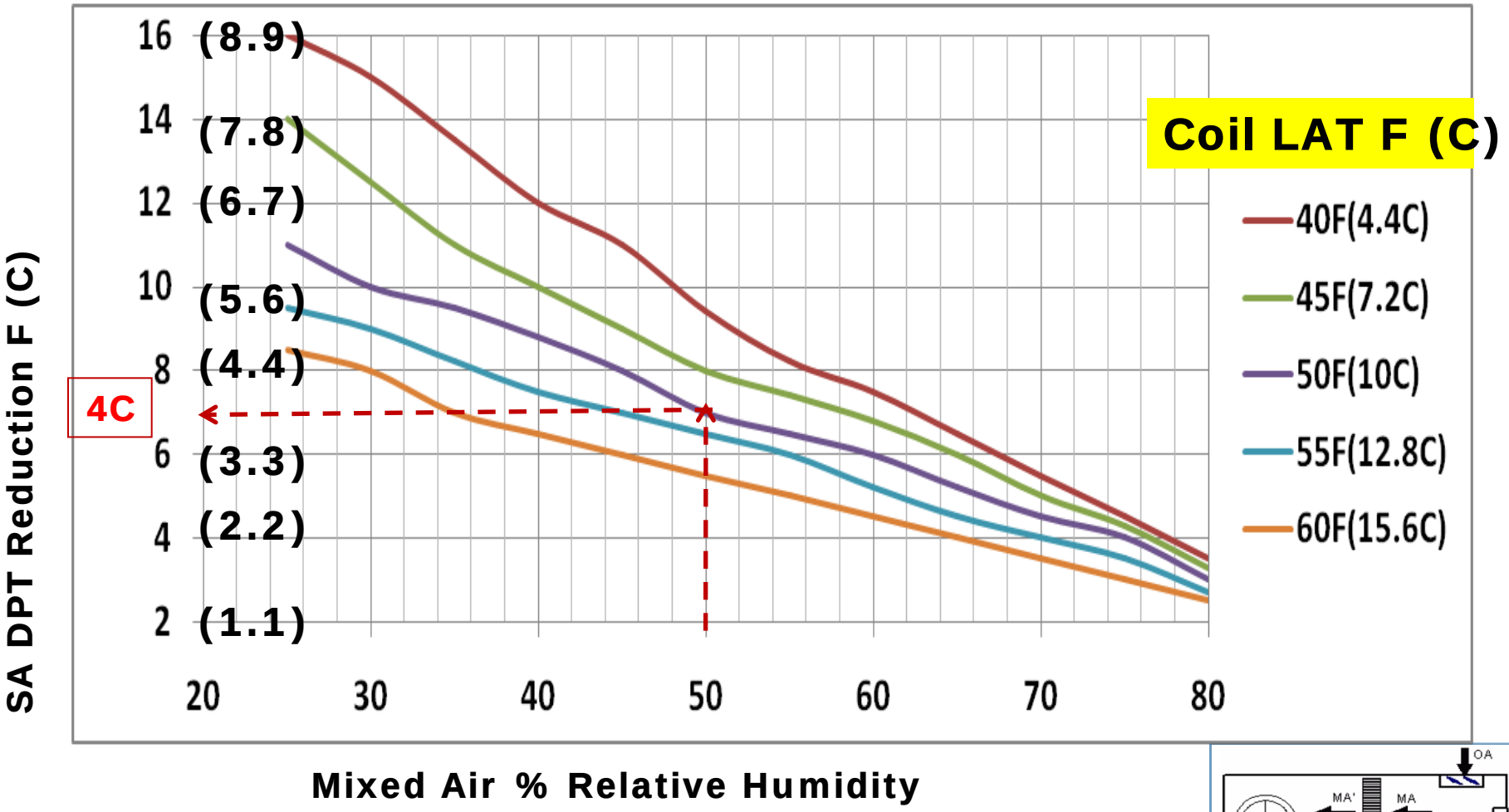
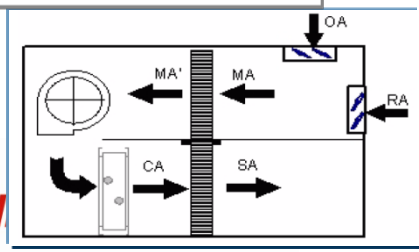
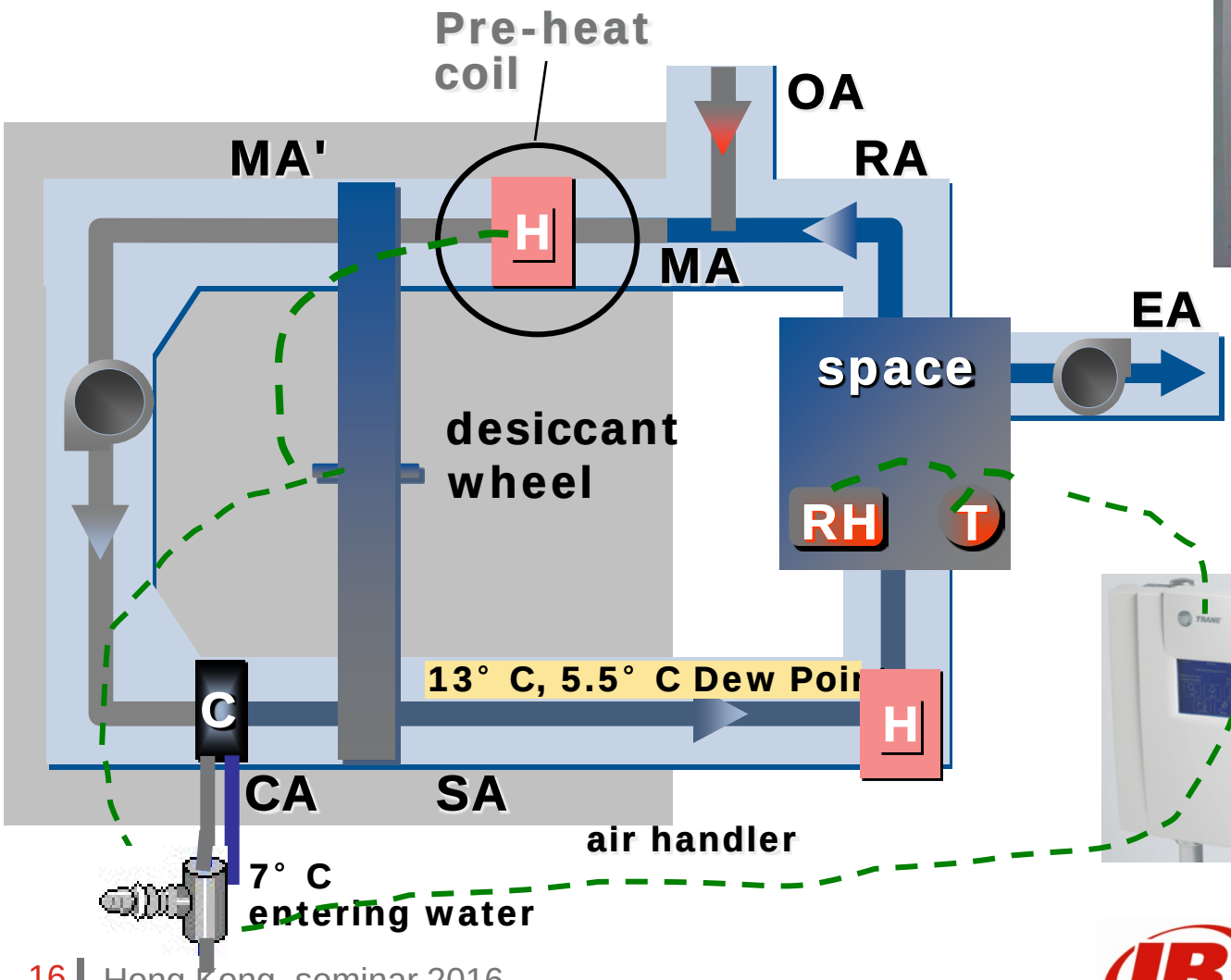
SA Dew Point (DPT)
reduction through the CDQ wheel





This is an estimation, will subject to design

Typical components for zones with high latent loads or high FA quantities



MP581 AHU mounted Trane controller

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RH & Temperature Measurement

Measurement 3:

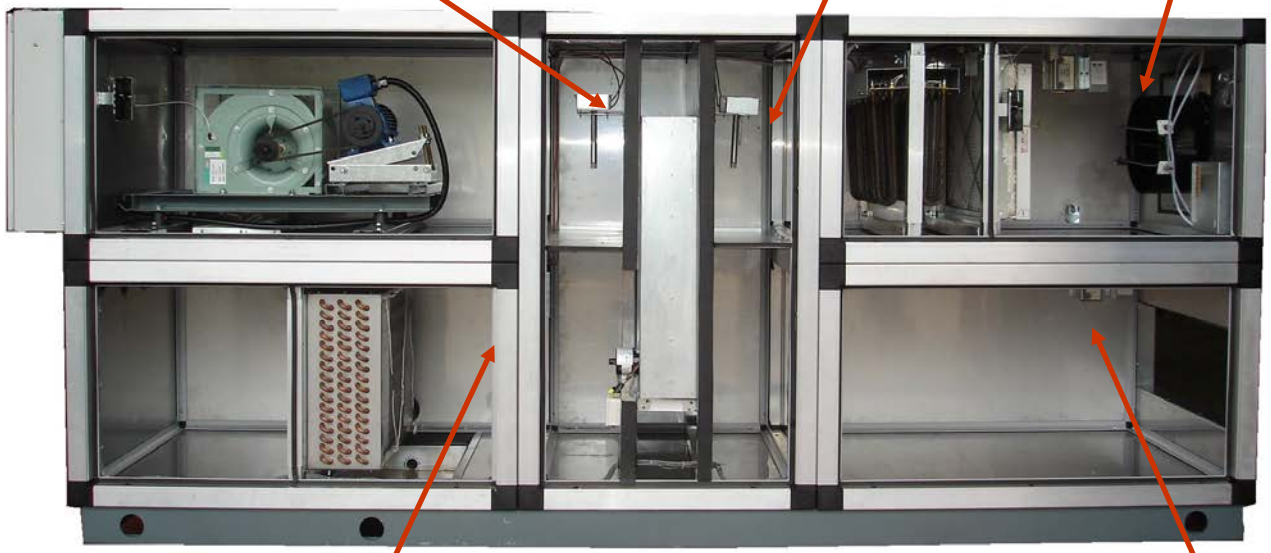
Off Wheel

Measurement 2:

On Wheel

Measurement 1:

Outdoor Air (OA)



Measurement 4:

Off Coil

Measurement 5:

Condition Air (CA)

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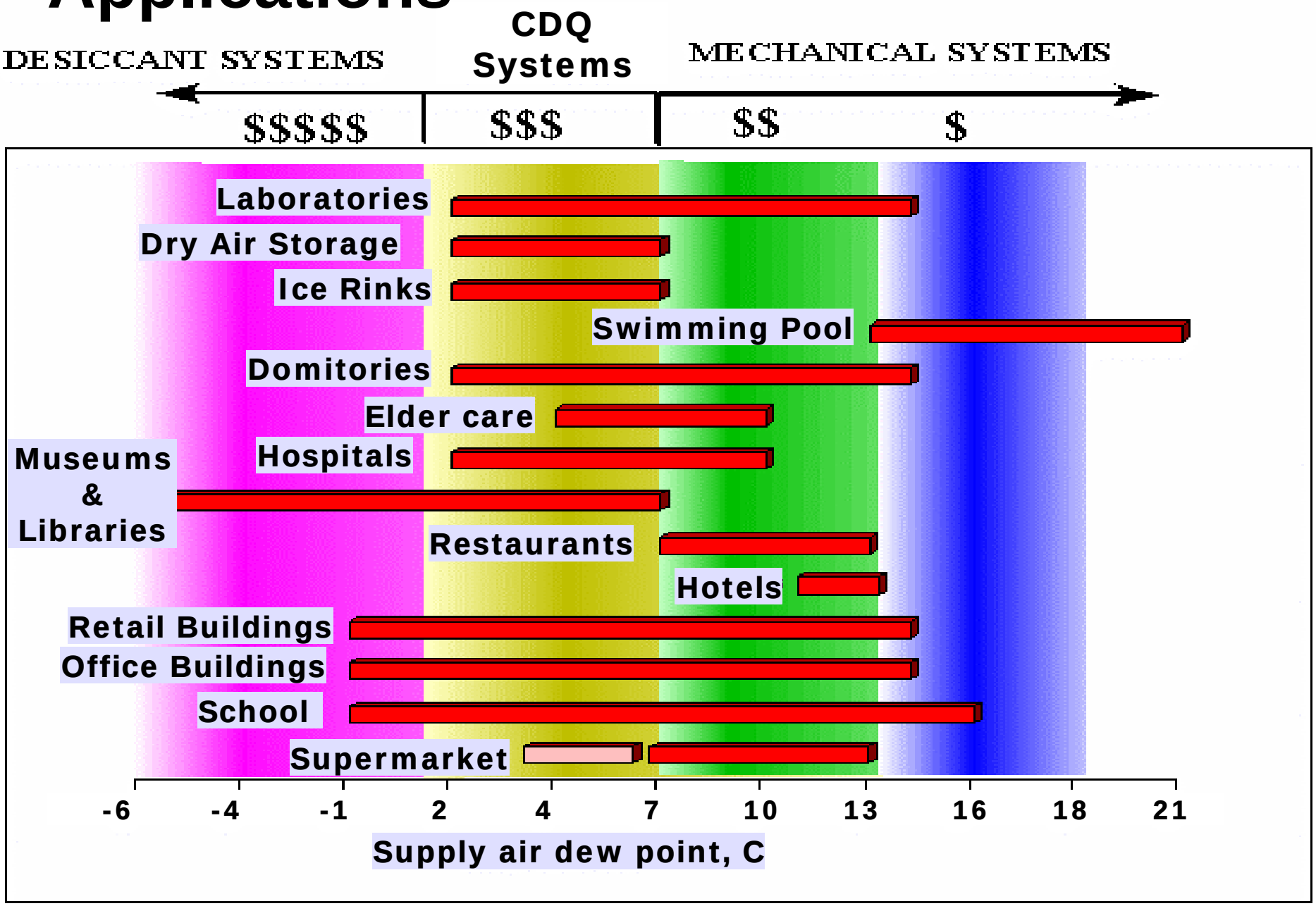
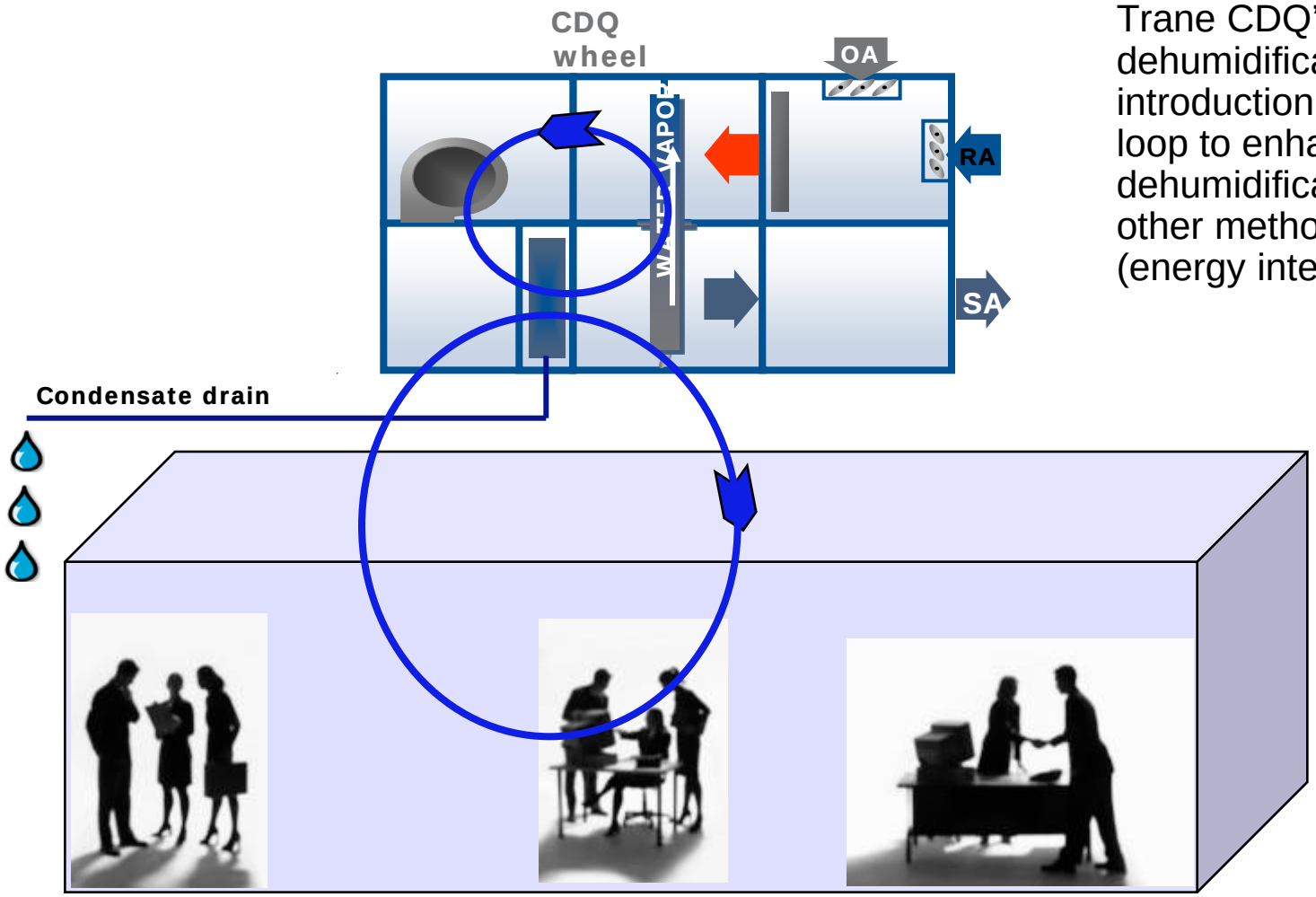
Applications



Energy efficient Dehumidification



Trane CDQ's primary dehumidification method is the introduction of 2nd moisture loop to enhance cooling coil dehumidification. This is unlike other methods that uses heat (energy intensive).

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Dehumidification Option Analysis

Type of dehumidification	Operating cost*	First cost
CDQ	2	5
Reheat	10	1
Heat activated desiccant system	9	6-8
Series run around coil loop	7	4
Series heat pipe	6	6

Rank is based on scale of 1-10, with 1 being low

* Include energy and maintenance cost

Case study 1 : Vichaiyuth Hospital and Medical Center (OT), Bangkok, Thailand

- Serve Royal/VIPs & others;
- Famous for Heart & Brain surgeries
- 500 patient rooms size & 200+ doctors
- Old hospital but now start to construct new extension

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Case study 1 : Vichaiyuth Hospital and Medical Center (OT), Bangkok, Thailand

- Issue : sometime it's too hot/too humid since no RH control.
- Uses several portable dehumidifiers in the OT room when required
- Room Design : 62 +/-1 deg F (17+/-0.6 deg C)DB and 50+/-5% RH with mixed air system

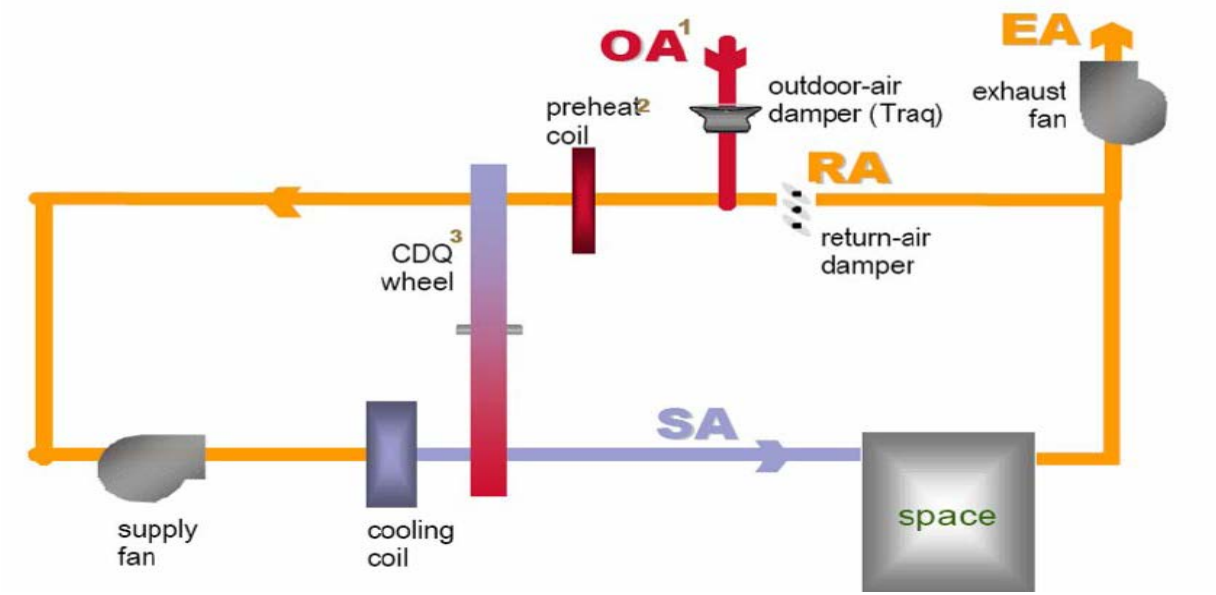
Case study 1 : Vichaiyuth Hospital and Medical Center (OT), Bangkok, Thailand

- Maintain positive pressure.
- Never exceed 12 hrs usage per day
- Class 1000-10000 clean room with ceiling HEPA(99.997%)
- System operate 24 hrs but reduce airflow during unoccupied mode to maintain +ve pressure

Case study 1 : Vichaiyuth Hospital and Medical Center (OT), Bangkok, Thailand

Room Design:
62 +/-1 Deg F (17+/-0.6 C)DB and 50+/-5% RH

CDQ Supply air condition:
DBT=52.4 deg F (11.3oC)
Dew Point T=42 deg F (5.6oC)
Humidity ratio=40 gr/lb (5.7g/kg)



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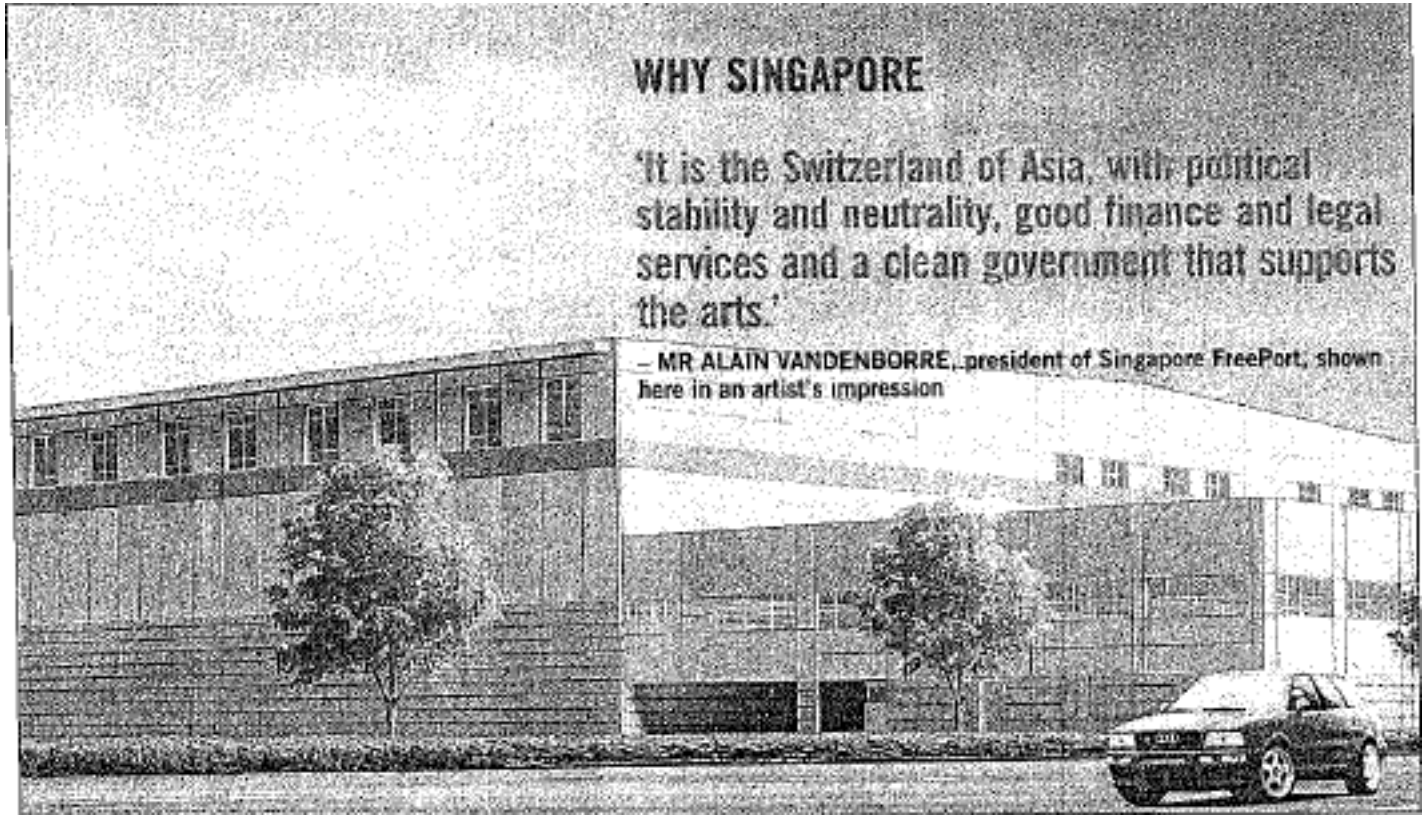
Case study 2 : Singapore Free Port



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Case study 2 : Singapore Free Port

- High security 12,000 sqm building
- storing art collections, cars, diamonds, exclusive antiques, etc
- Owned by Swiss Company NLC & Singapore's National Arts Council, National Heritage Board
- Room Design: 1st Storey: 18C/50%RH 2nd & 3rd Storey: 22C/50%RH
- Original design : based on traditional active solid desiccant dehumidifier system

Case study 2 : Singapore Free Port

Description of system

AHU	Total KW	Sen KW	Fresh Air CFM	Total CFM	Remarks
1-1	151	107	1825	35100	18C/55%RH
1-2	144	102	1745	33490	18C/55%RH
2-1	132	93	1840	28040	22C/55%RH
2-2	130	92	1815	27660	22C/55%RH
3-1	141	105	1840	32040	22C/55%RH
3-2	140	104	1815	31605	22C/55%RH

Case study 2 : Singapore Free Port

Description of system

AHU 2-1	
Room DB	22C
Room Gr/Lb	52
Airflow	16494 CFM
Fresh Air	1082 CFM
Room Total Load	132 kW
Room Sensible Load	93 kW

- Sensible Load = 1.085 x CFM x Delta T

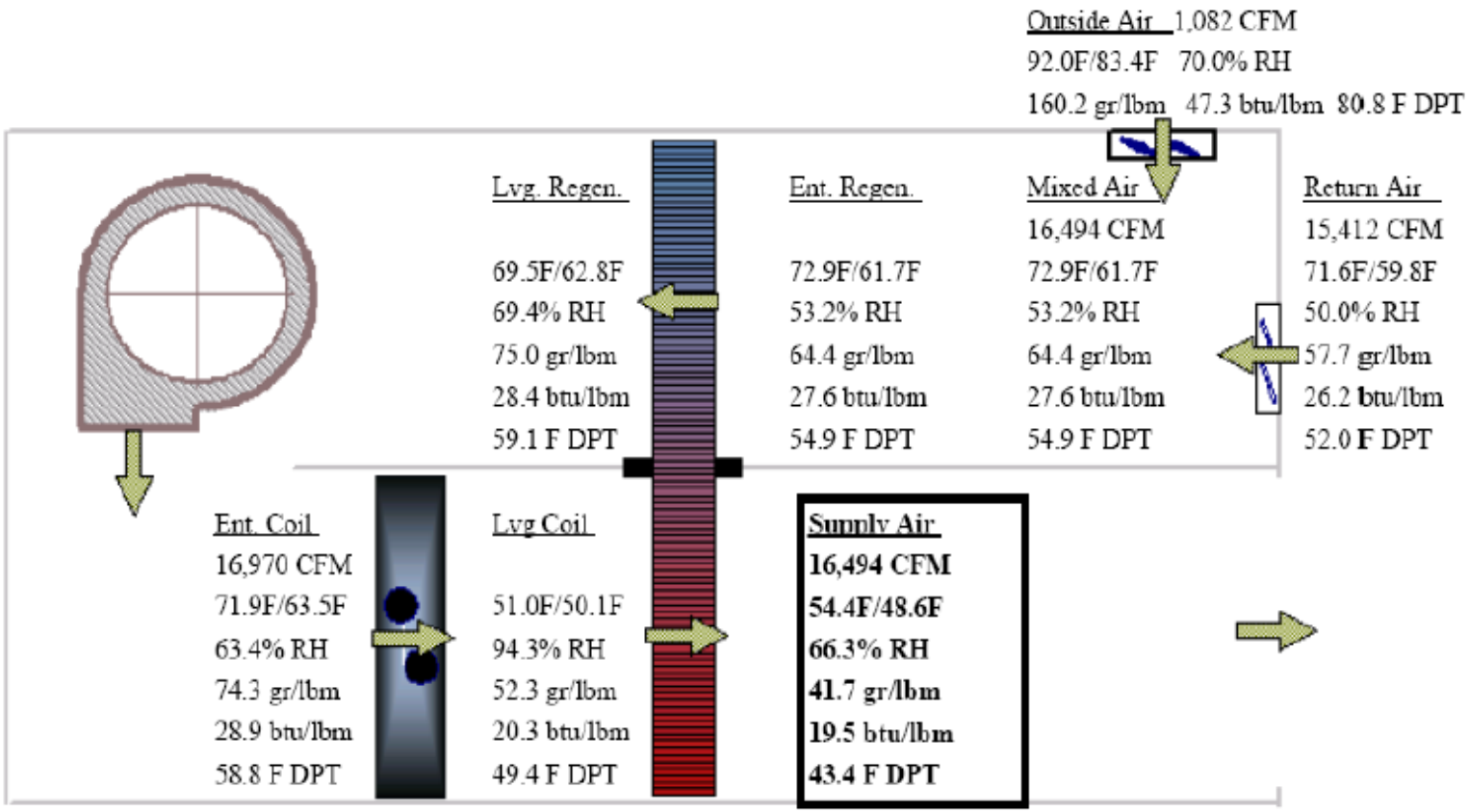
  Supply air Temperature = 12C (54F)

- Latent Load = 0.68 x CFM x Delta Gr/Lb

  Supply air humidity ratio = 40 gr/lb (5.7g/kg)

Case study 2 : Singapore Free Port

Description of system



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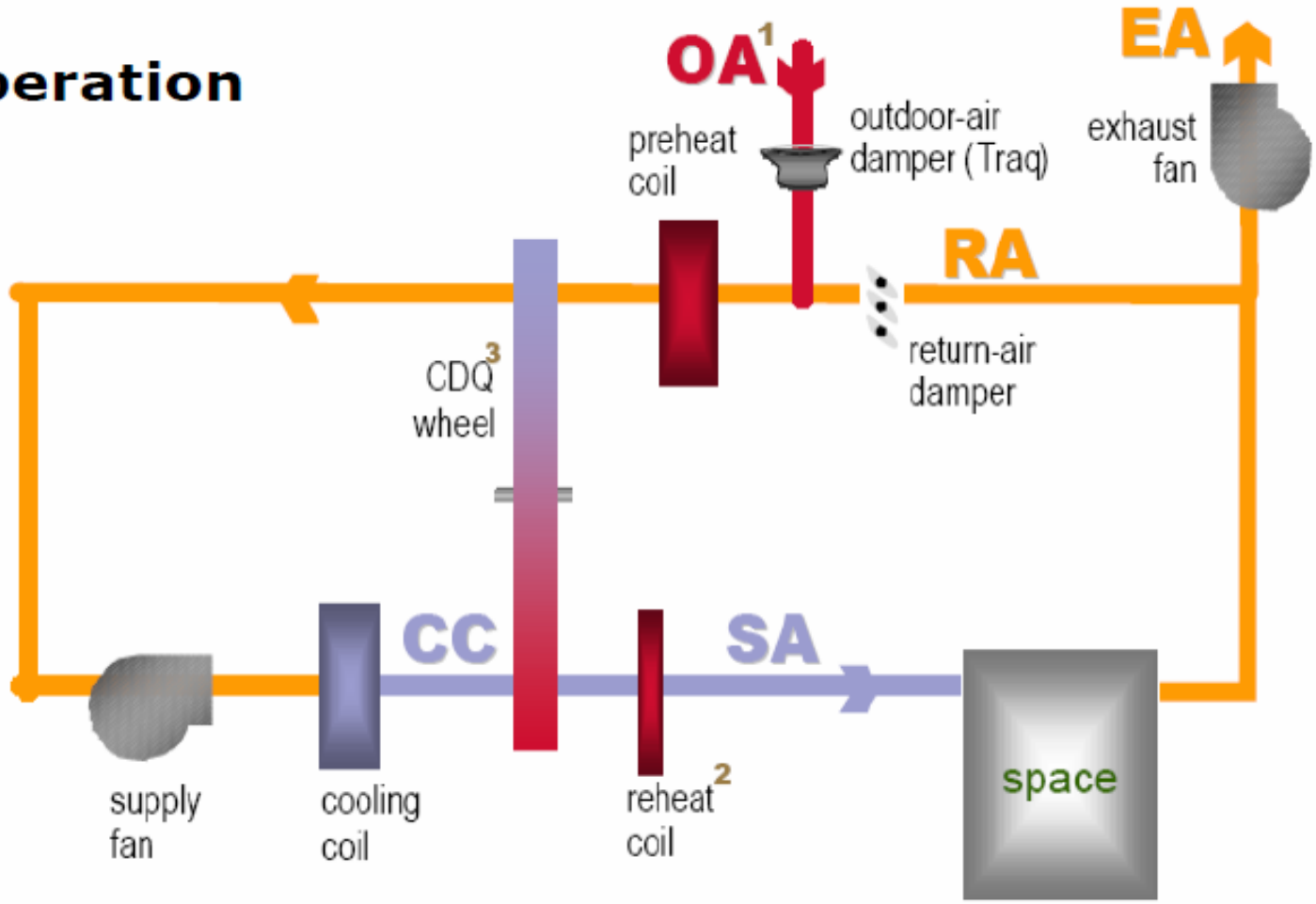
Control Operation Sequence



1 Outside Air can be before or after the first pass of the wheel

2 Reheat coil used during dehumidification, preheat coil used during dehumidification and winter heating.

3 Where space permits, bypass dampers can be placed around the wheel to minimize pressure loss when wheel is off

10/4/.

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Control Mode		Psychrometric Conditions[1]	Control Actions	Comments
O1	Occupied cooling	Rhspace < Rhsetpoint DBTspace > space DBT cooling setpt DBToa > DBT econ on	• Stop the CDQ wheel • Modulate the cooling coil to meet space DBT cooling setpoint • Reheat coil is off	• Space RH is below the desired upper limit, so the CDQ wheel is turned off • Cooling coil satisfies the space dry-bulb cooling setpoint
O2a	Occupied cooling and dehumidification[5] (stage 1)	Rhspace > Rhsetpoint[5] DBTspace > space DBT cooling setpt DBToa > DBT econ on	• Rotate the CDQ wheel • Modulate the cooling coil to meet space DBT cooling setpoint • Reheat coil is off • Operate in this mode until Rhspace drops 5% below the occupied Rhsetpoint	• Space RH is above the desired upper limit • Rotating the CDQ wheel results in enhanced dehumidification • Cooling coil satisfies the space dry-bulb cooling setpoint
O2b	Occupied dehumidification[5] (stage 2)	Rhspace > Rhsetpoint + 3%[5] DBTspace > space DBT cooling setpt or space DBT heating setpt < DBTspace < space DBT cooling setpt DBToa > DBT econ on	• Rotate the CDQ wheel • Open the cooling coil valve to 100% • Modulate the reheat coil to meet space DBT cooling setpoint • Operate in this mode until Rhspace drops 5% below the occupied Rhsetpoint	• Space RH is above the desired upper limit • Rotating the CDQ wheel results in enhanced dehumidification • Cooling coil valve is wide open • Reheat coil satisfies the space dry-bulb cooling setpoint
O2c	Occupied dehumidification[5] (stage 3)	Rhspace > Rhsetpoint + 5%[5] DBTspace > space DBT cooling setpt or space DBT heating setpt < DBTspace < space DBT cooling setpt DBToa > DBT econ on	• Rotate the CDQ wheel • Cooling coil valve is open to 100% • Modulate the reheat coil to meet space DBT cooling setpoint • Modulate the preheat coil to maintain DBTcc = DBTcc,design, but do not allow the reheat coil valve to close further than 5% open • Operate in this mode until Rhspace drops 5% below the occupied Rhsetpoint	• Space RH is above the desired upper limit • Rotating the CDQ wheel results in enhanced dehumidification • Cooling coil valve is wide open • Reheat coil satisfies the space dry-bulb cooling setpoint • Preheating the air entering the upstream side of the CDQ wheel lowers the DPT, and raises the DBT, of the air leaving the downstream side of the wheel

Control Operation Sequence

CDQ Project List (Asia)

1. Vichaiyuth Hospital & Medical Center,Bangkok (Operating Room);6xCDQ
2. Acushnet,Bangkok (Plant for Golf set) :5XCDQ
3. Ulpha-Pharmaceutical factory in Kuala Lumpur :4XCDQ
4. Fitness center and indoor swimming pool in Taipei:1XCDQ
5. Glasshouse Garden(Bio tech)-Singapore:4XCDQ
6. Glommed- Pharmaceutical factory in Vietnam:1XCDQ
7. Bangkok Air,Bangkok-Pilot Simulation Room: 2XCDQ
8. USM – Biological lab for university researches in Penang:5XCDQ
9. Taiguan Electric in Zhongsan-Electronic Assembly:1XCDQ
10. Jelly Belly,Bangkok -Food processing plant:5XCDQ
11. Nutrica, NewZealand-Baby food processing:1XCDQ
12. ARV GPO,Bangkok-Pharmaceutical plant for HIV :108XCDQ
13. Bangkok Air,Bangkok phase 2-Pilot Simulation Room: 2XCDQ
14. Phuket Hospital(OT) -3xCDQ
15. Reckitt Benckiser (Stepsil manufacturer).-3xCDQ
16. Dielac Milk factory(Vietnam)-2xCDQ
17. Eden Swimming pool(Vietnam)-1xCDQ

CDQ™- Summary

- Highly energy efficient humidity control
- Highly reliable humidity control
- 3- 8ºC lower dew point than cooling coil
- New technology made possible by innovative R&D by Trane

Questions?

Thank You!