

SISTEMAS DE ÁGUA GELADA



PROGRAMA
BRASILEIRO DE
ELIMINAÇÃO DOS
HCFCs
Projeto para o Gerenciamento de Chillers

Projeto Demonstrativo para o Gerenciamento Integrado no Setor de Chillers

Resfriamento Dedicado de Ar Exterior

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27/04/2016 – São Paulo, Brasil

Execução



Implementação



*Empoderando vidas.
Fazendo a diferença.*

Realização

Ministério do
Meio Ambiente



Sistemas Dedicados de Ar Externo



OBJETIVOS da Apresentação:

- O que é DOAS
- Porque utilizar DOAS
- Possíveis sistemas de climatização para ventilação
- Análise Psicrométrica
- DOAS em sistemas de Água Gelada
- Case Exemplo – Escritório em Fortaleza
- Fazer sistema com 27 fan coils sair mais barato do que sistema com 25 fan coils – *e com mais conforto!*



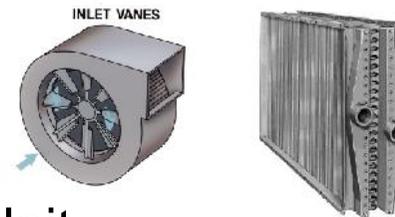
DOAS = “Dedicated Outdoor Air System”



Uma unidade DOAS é um tipo de Sistema HVAC dedicado ao condicionamento e insuflamento de ar externo.

Os componentes do equipamento DOAS são parecidos a fan coils.

DOAS (V) + Sistemas Auxiliares (HAC) = Completo Sistema de HVAC de Ar Externa



Tambem conhecido como:

“OAHU” Outside Air Handling Unit

“UTAE” Unidade de Tratamento de Ar Externa
&

“HVAC” Heating Ventilation & Air Conditioning

“FCU” Fan Coil Unit



DOAS – Definição AHRI



- *DOAS ou “Dedicated Outdoor Air System” é um produto que, através de condensação a Ar, condensação a Água ou dos denominados “water sources”, desumidifica 100% do ar externo para o ponto de orvalho e inclui reaquecimento que é capaz de aumentar a temperatura de bulbo seco do ar para a condição projetada para o ambiente.*

Este ar externo condicionado é então insuflado direta ou indiretamente no espaço condicionado. Ele pode pré-condicionar o ar externo através de “rodas térmicas”, trocadores de calor ou outros aparatos de transferência de massa e/ou calor.

Edificação com DOAS



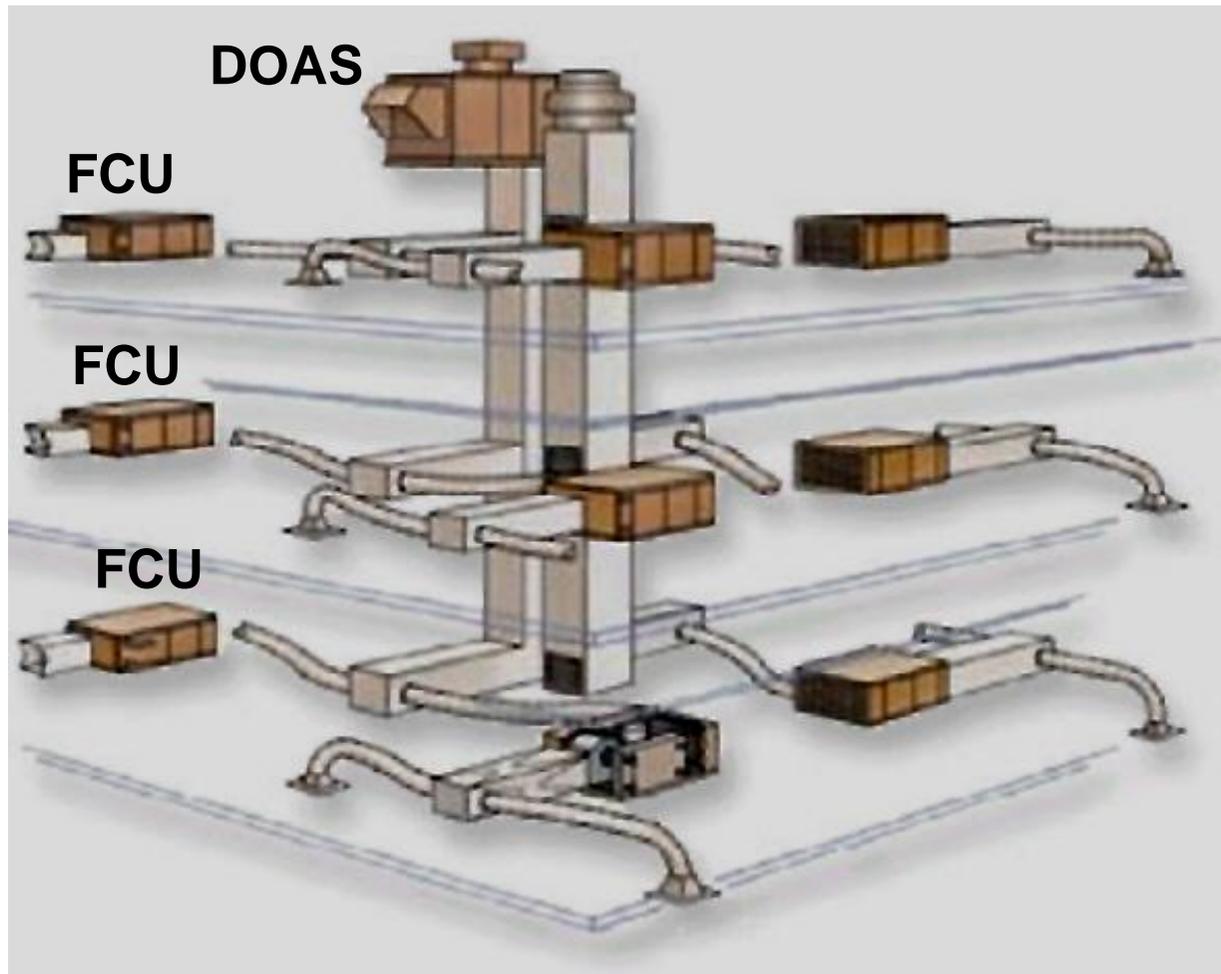
- Sistema Dedicado de Ar Externo.
 - . Unidade de 100% de ar externo e Sistema de Distribuição que Condiciona e Insufla o Ar



- Unidades de Resfriamento & Aquecimento Auxiliares.
 - . Somente Resfriamento ou Resfriamento/Aquecimento de zonas
 - . Mantém as condições das zonas
 - . Exemplo de Unidades:
 - . VRF, RTU, Splitão, AHU, Vigas Frias

Ar Externa do DOAS aos FCU

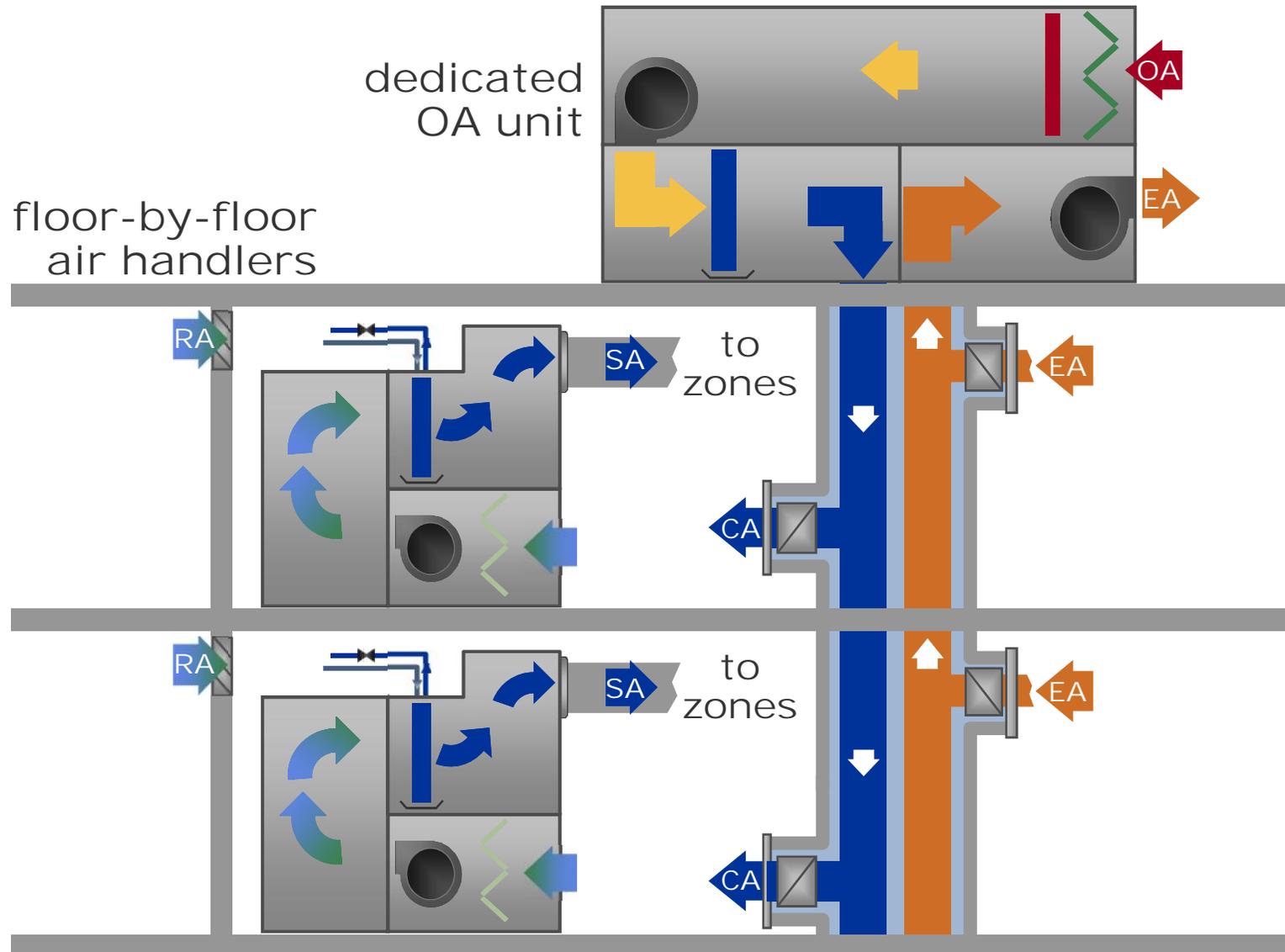
- Equipamento DOAS entrega ar externa pre-tratada via rede de dutos dedicado para FCU's individuais



Os climatizadores individuais podem ser do tipo:

- *blower-coils*
- *rooftop units*
- *air handlers*
- *self-contained units*
- *dual-duct VAV boxes*
- *Chilled Beams*

Ar Externa do DOAS direto ao Ambiente



Importancia de Ventilação & Umidade



Examination rooms - Big problems with mold

Looking inwards... from the



Importancia de Ventilação & Umidade



NORMA
BRASILEIRA

ABNT NBR
16401-3



ANSI/ASHRAE Standard 62.1-2007
(Supersedes ANSI/ASHRAE Standard 62.1-2004)
Includes ANSI/ASHRAE Addenda listed in Appendix I

ASHRAE STANDARD

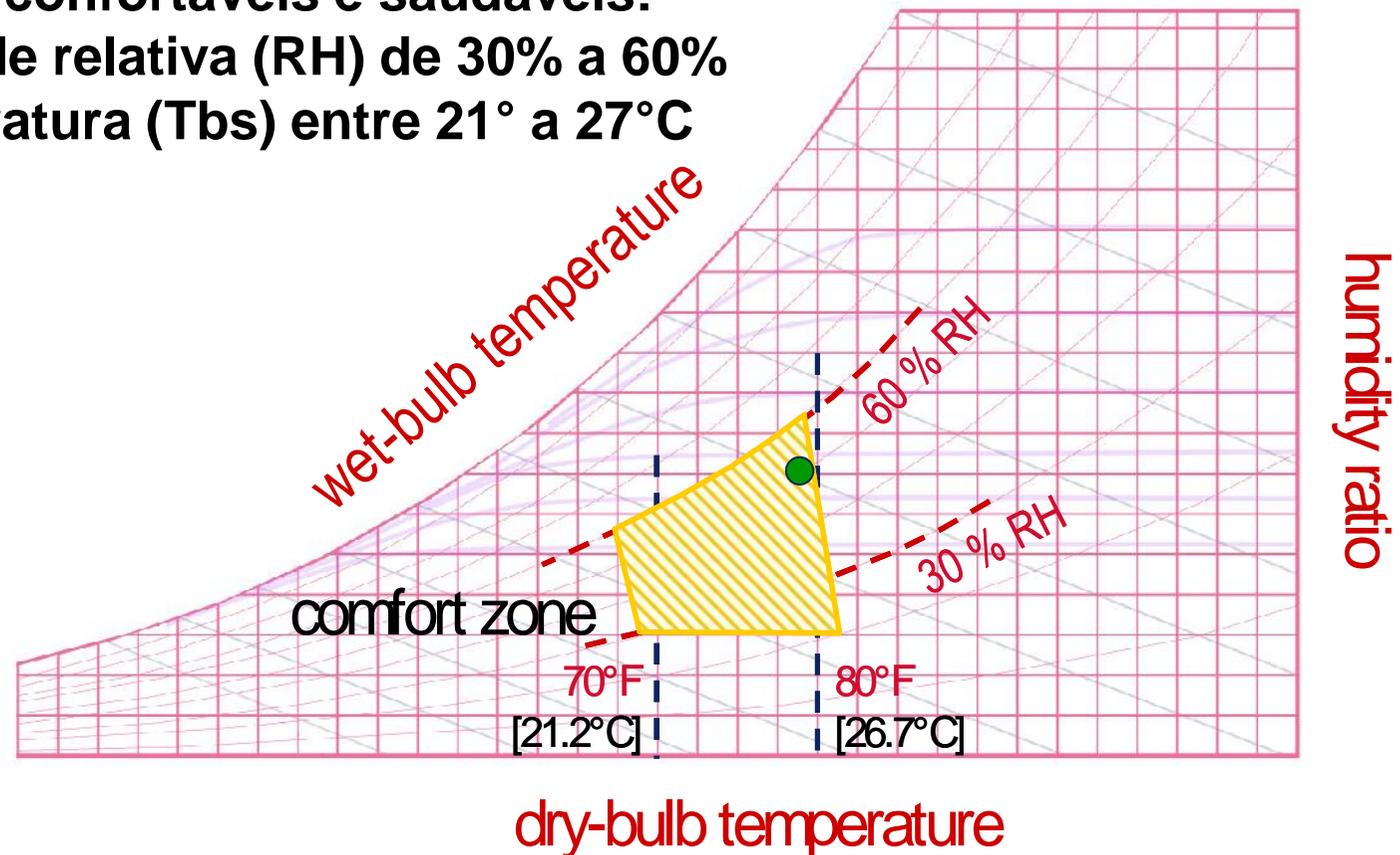
Ventilation for Acceptable Indoor Air Quality

Refrigeração, Calor, e Umidade

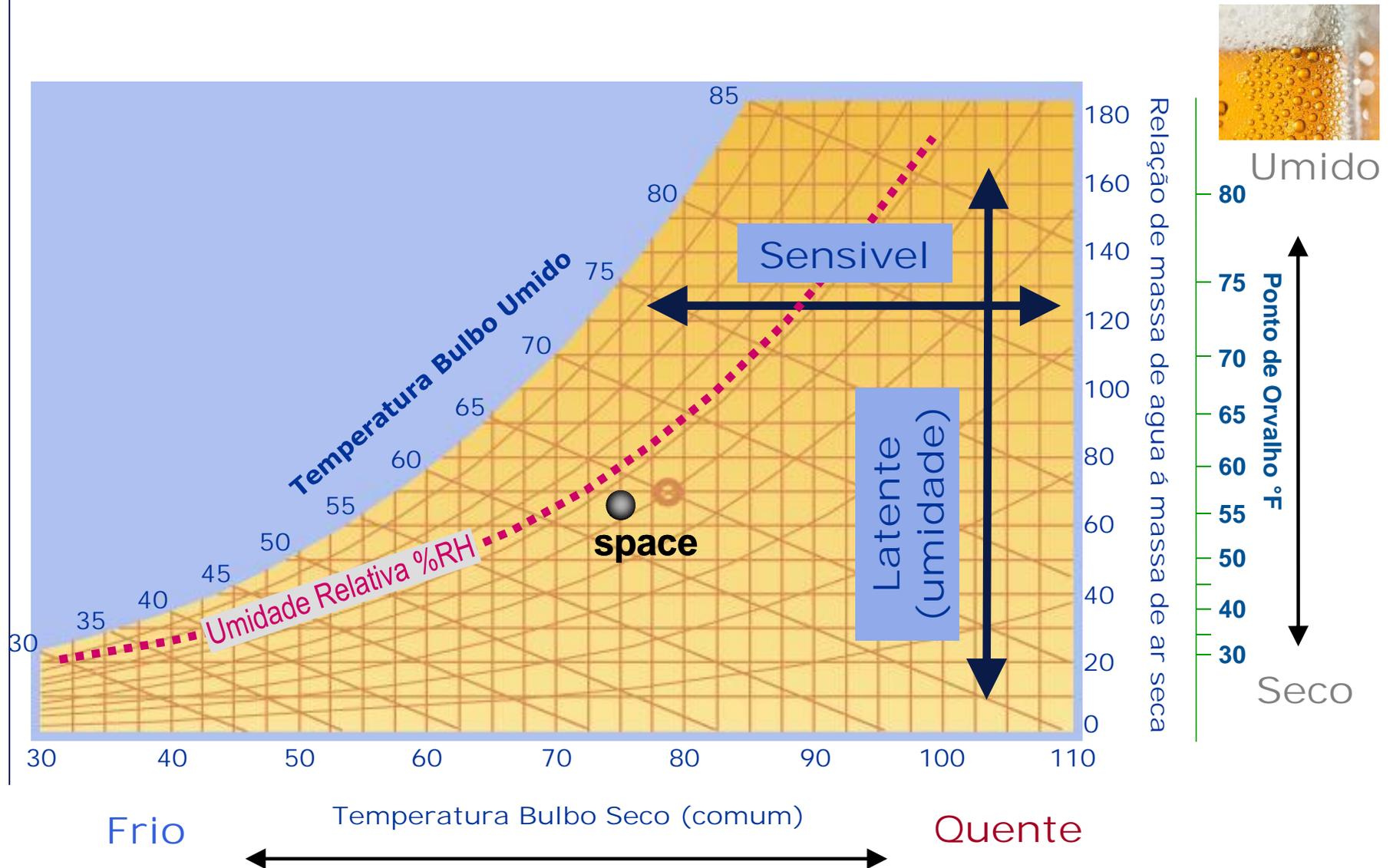


Proposito de ar condicionado: Remover calor e umidade.

- Ambientes confortáveis e saudáveis:
 - Umidade relativa (RH) de 30% a 60%
 - Temperatura (Tbs) entre 21° a 27°C



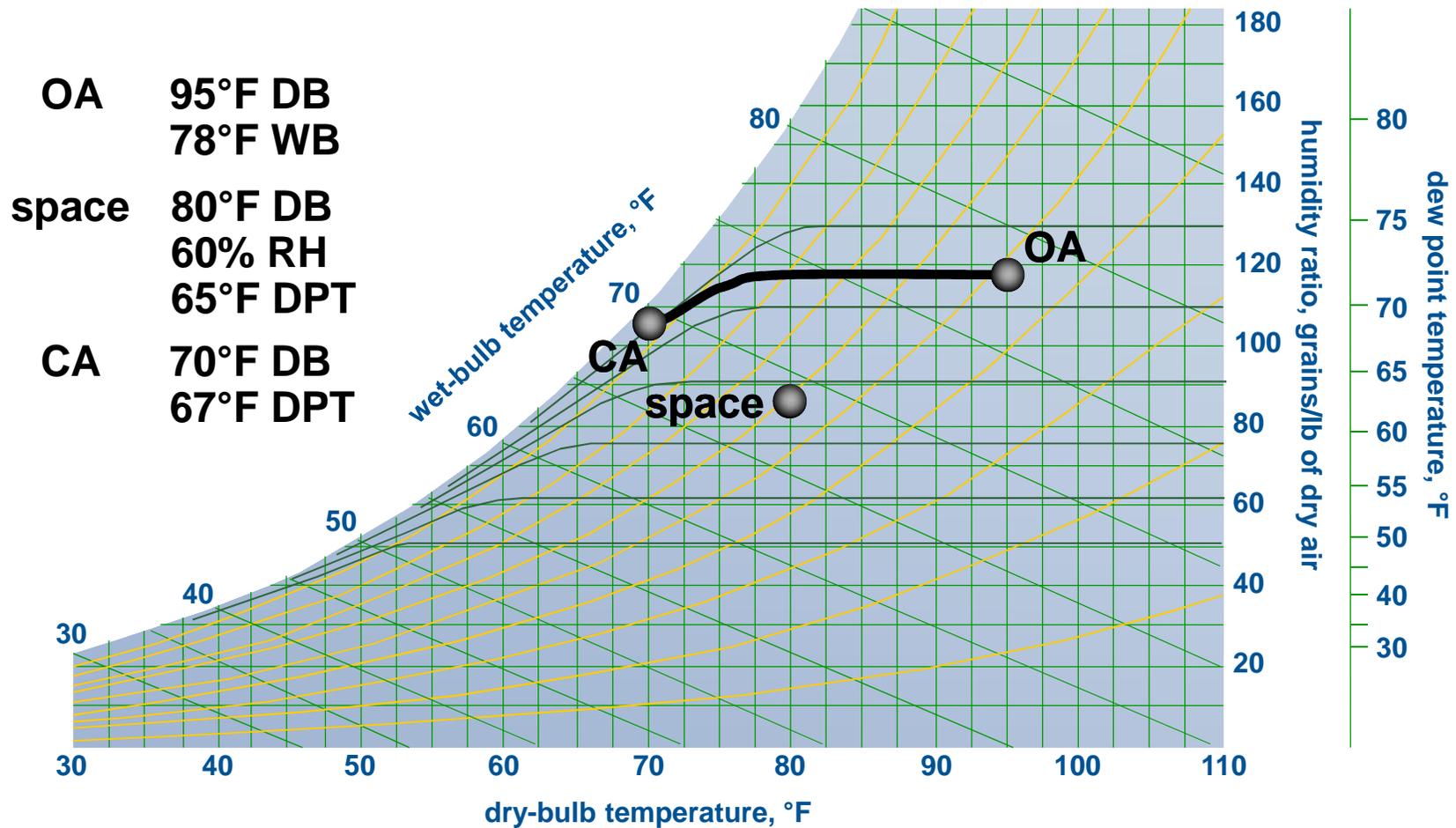
Carta Psicrometrica



Manobras na Carta Psicrometrica



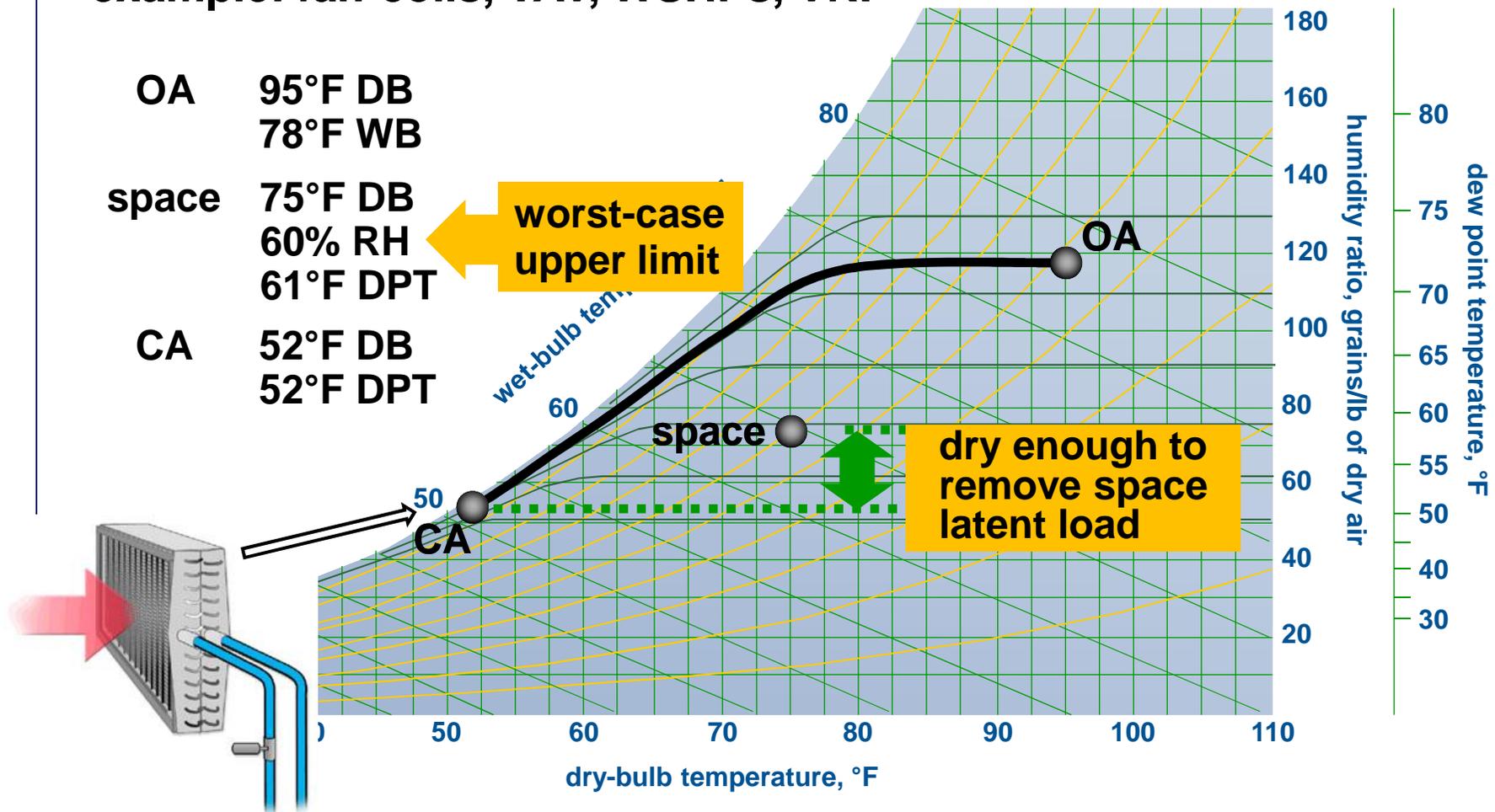
Esfriado *mas* não Desumidificado



Manobras na Carta Psicrometrica

Esfriado e Desumidificado

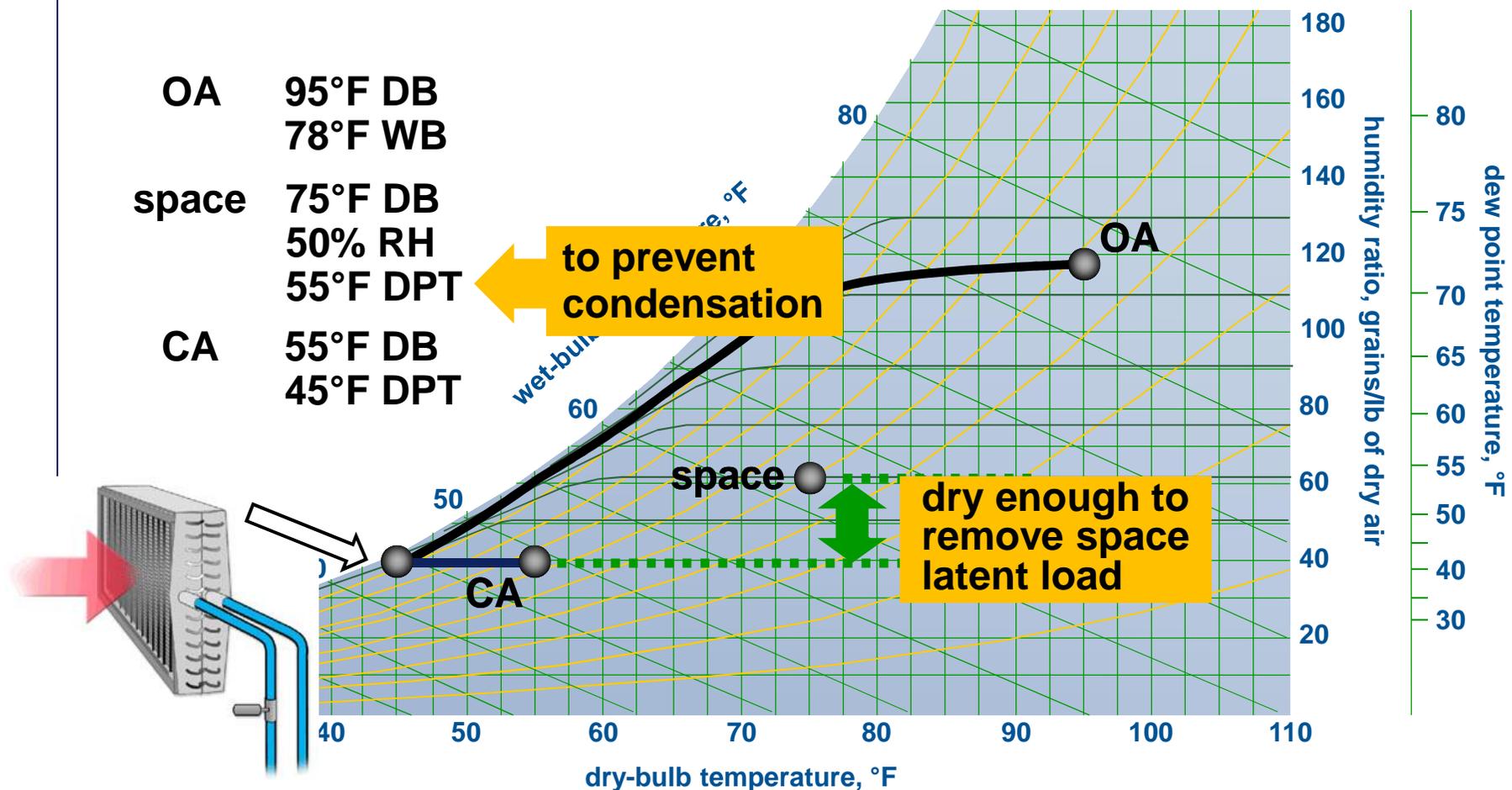
example: fan-coils, VAV, WSHPs, VRF



Manobras na Carta Psicrometrica

Esfriado e 'super' Desumidificado

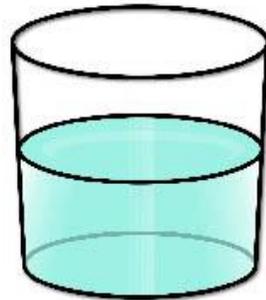
example: chilled beams, radiant cooling



Troca de calor

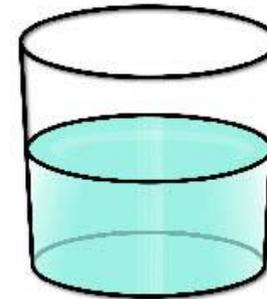
Sensível

1 kg
água



15°C

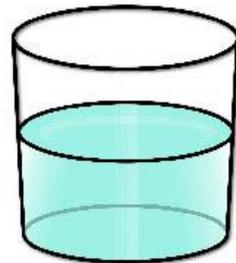
+ 85 kcal =



100°C

Latente

1 kg
água



100°C

+ 244.5 kcal =



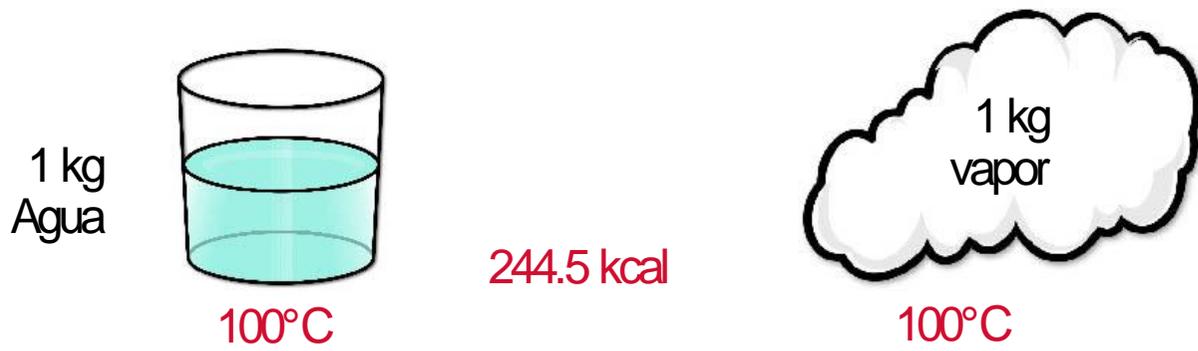
1 kg
vapor

100°C

Calor Sensível vs Calor Latente

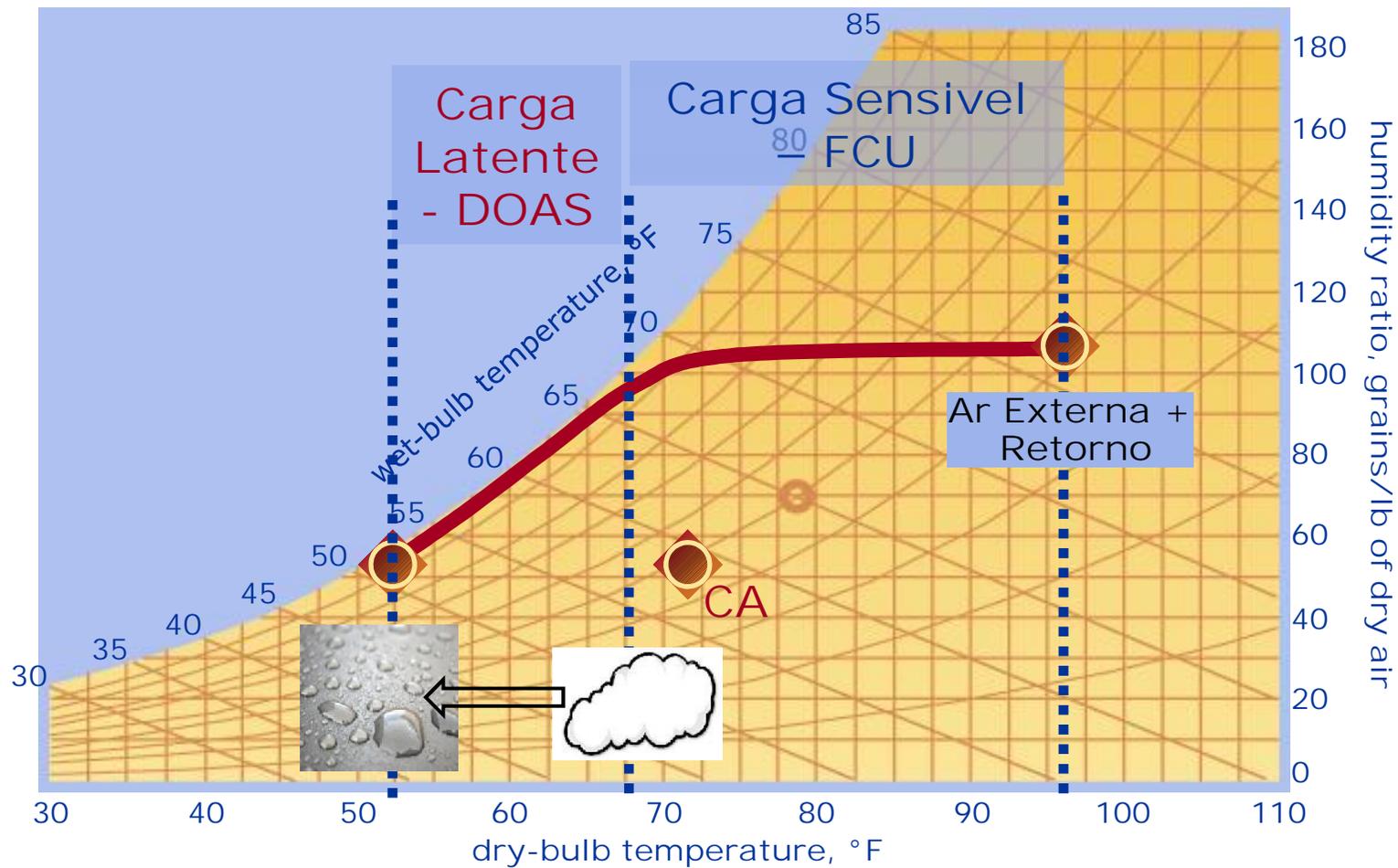


Carga Sensível
– Mudança de
Temperatura

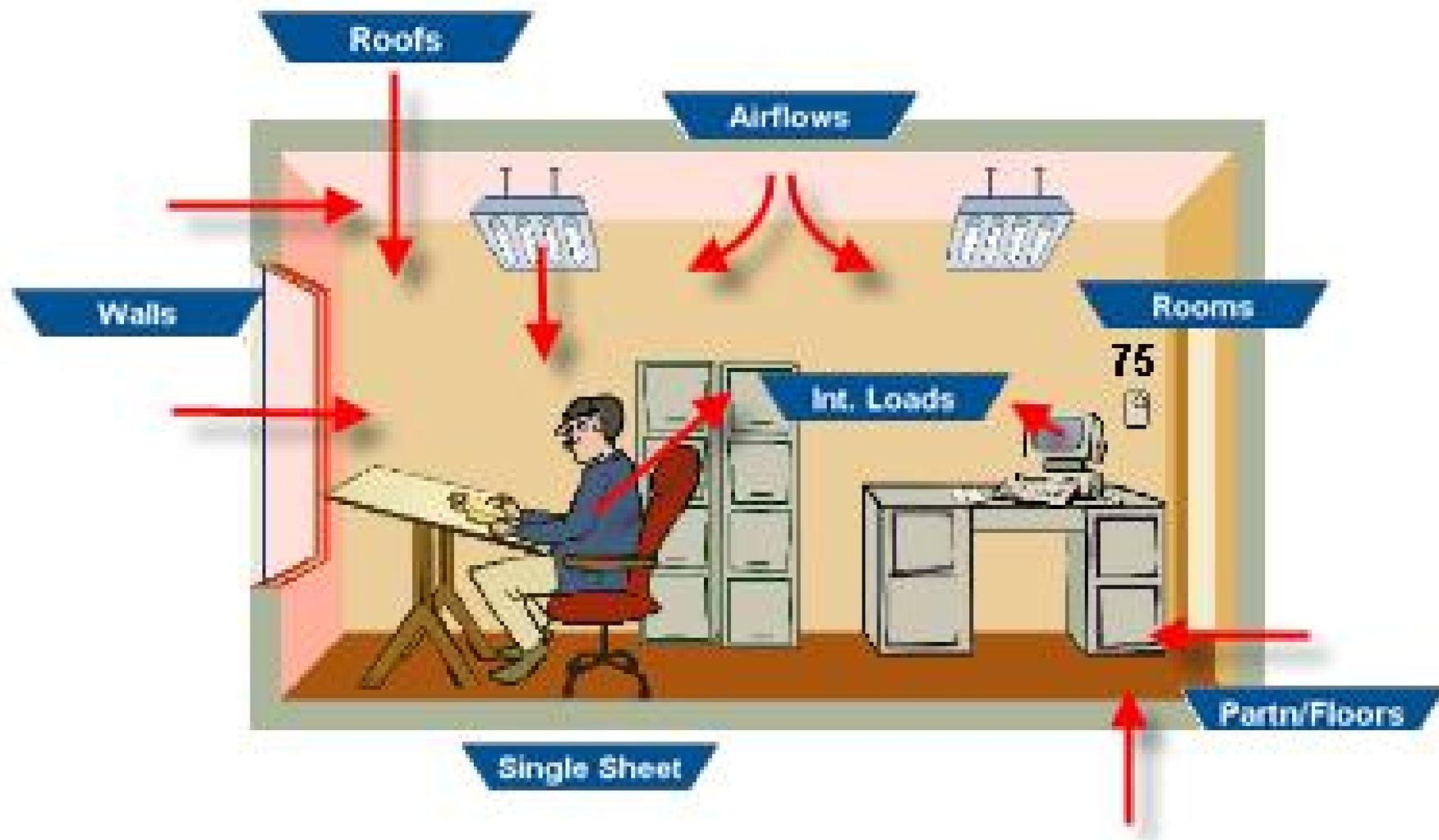


Carga Latente –
Troca de
Fase

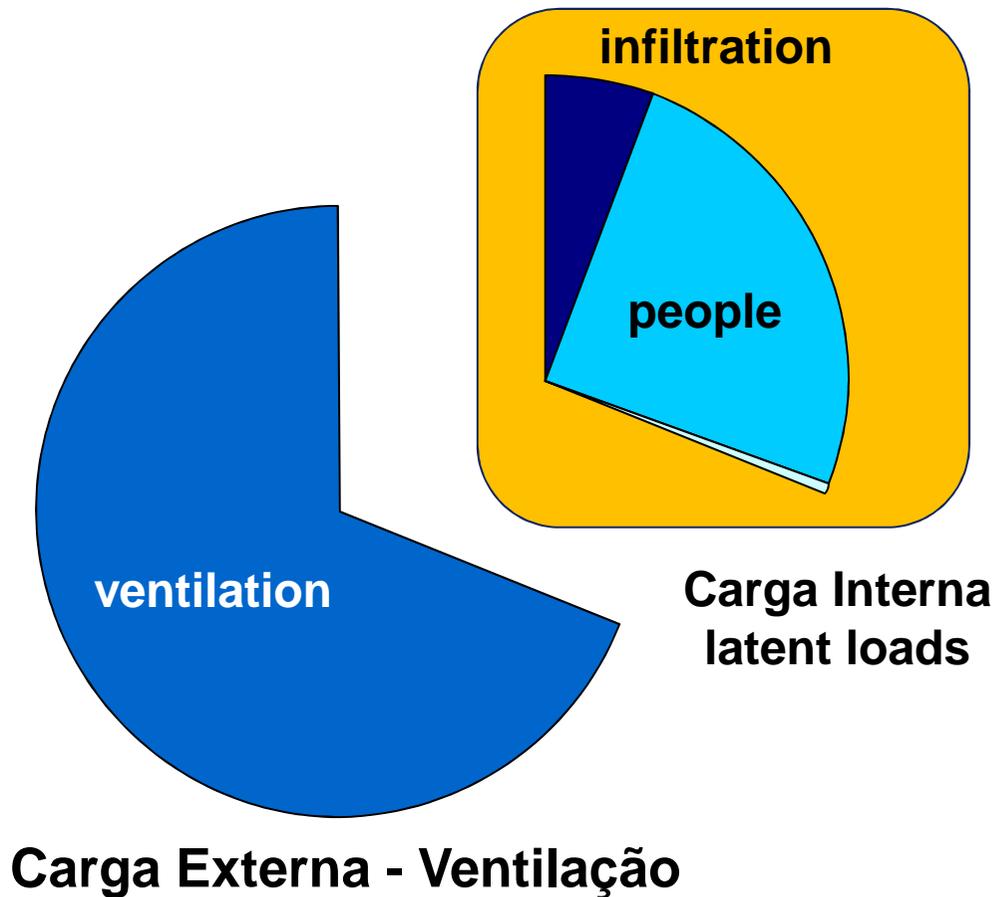
DOAS - Desacoplar Cargas Sensíveis e Latentes



Origem de Cargas Latentes em Edifícios



Origem de Cargas Latentes em Edifícios

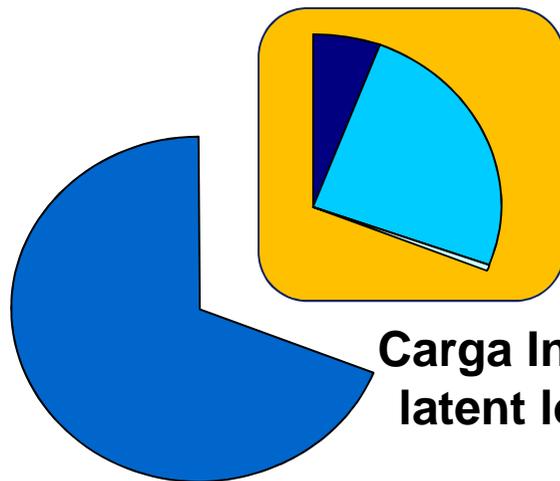


Origem de Cargas Latentes em Edifícios



COOLING COIL LOAD INFORMATION

Load Component	Sensible kW	Latent kW	Total kW	Percent of Total
Solar Gain	0.00		0.00	0.0%
Glass Transmission	0.00		0.00	0.0%
Wall Transmission	0.00		0.00	0.0%
Roof Transmission	0.00		0.00	0.0%
Floor Transmission	0.00		0.00	0.0%
Adj Floor Transmission	0		0.00	0.0%
Partition Transmission	0.00		0.00	0.0%
Net Ceiling Load	0.00		0.00	0.0%
Lighting	6.48		6.48	5.8%
People	7.31	7.09	14.40	12.8%
Misc. Equipment Loads	8.64	0.00	8.64	7.7%
Cooling Infiltration	4.76	11.84	16.60	14.8%
Sub-Total ==>	27.19	18.93	46.12	41.1%
Ventilation Load	6.82	16.95	23.77	21.2%
Exhaust Heat	-1.65	0.00	-1.65	-1.5%
Supply Fan Load	0.00		0.00	0.0%
Return Fan Load	0.00		0.00	0.0%
Net Duct Heat Pickup	0.00		0.00	0.0%
Wall Load to Plenum	0.00		0.00	0.0%
Roof Load to Plenum	5.41		5.41	4.8%
Adj Floor to Plenum	0		0	0.0%
Lighting Load to Plenum	6.48		6.48	5.8%
Misc. Equip. Load to Plenum	0.00	0.00	0.00	0.0%
Glass Transmission to Plenum	0.00		0.00	0.0%
Glass Solar to Plenum	0.00		0.00	0.0%
Over/Under Sizing	31.97		31.97	28.5%
Reheat at Design	0.00	0.00	0.00	0.0%
Underfloor Sup Heat Pickup	0		0	0.0%
Supply Air Leakage	0	0	0	0.0%
Total Cooling Loads	76.22	35.88	112.10	100.0 %



Carga Interna latent loads

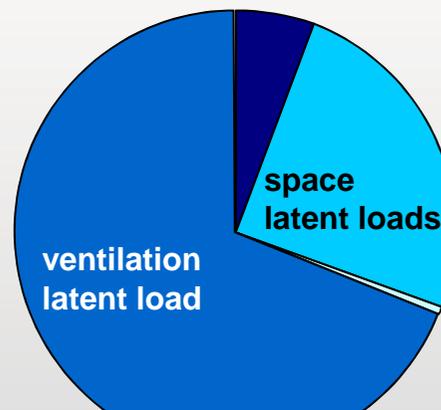
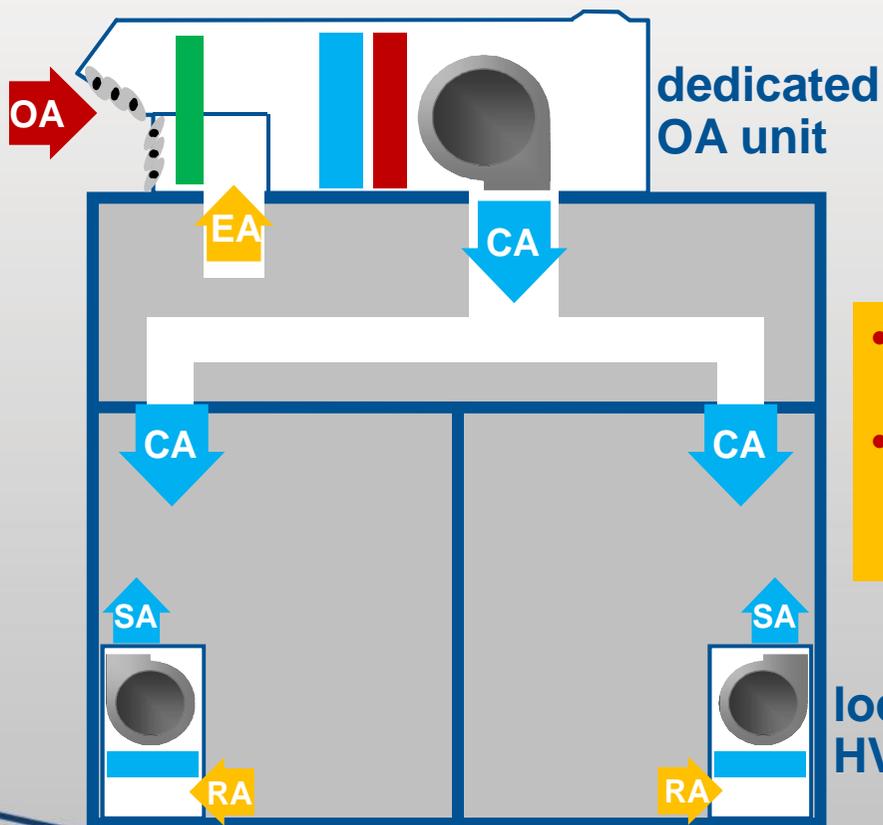
Carga Externa - Ventilação

Duvidas para o Engenheiro



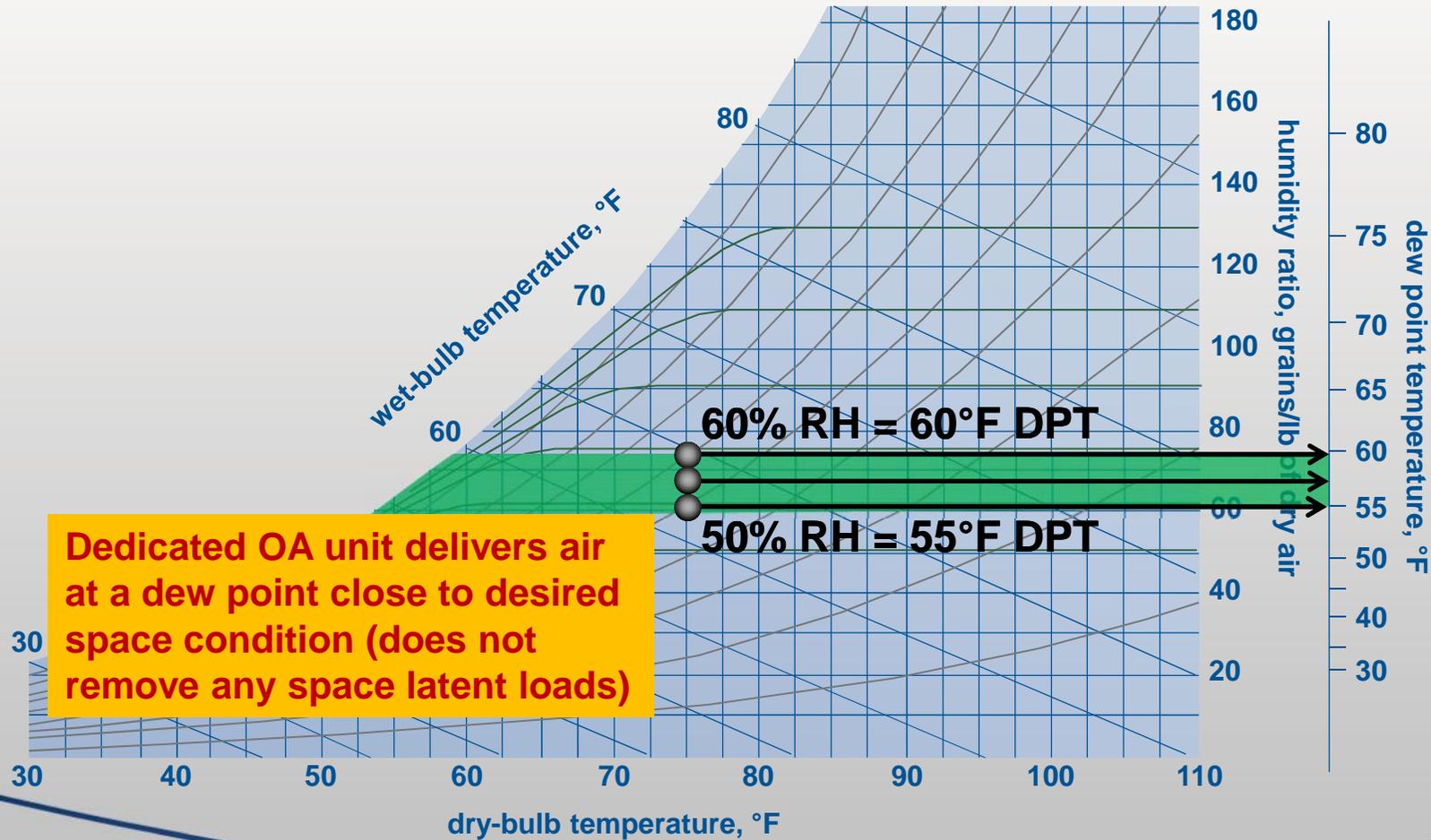
- **Devo utilizar DOAS?**
- **Qual Configuração de DOAS?**
 - **Ar Externa direto para ambiente?**
 - **Ar Externa direto para Fan Coils?**
 - **Outros?**
- **Qual Temperatura de ar insuflamento deve ser utilizado:**
 - **Nos Fan coils?**
 - **No DOAS?**
- **Qual Temperatura minima de agua deve ser produzido pelos chillers?**
- **Pode ser sistema Expansão Direta em vez de Agua Gelada?**
- **Qual solução vai apresentar custo inicial menor?**
- **Qual solução vai gera menor custo operacional?**
- **Qual solução vai garantir o melhor nível de conforto nos ambientes?**

what is the dehumidification duty? Dehumidify Ventilation Air Only



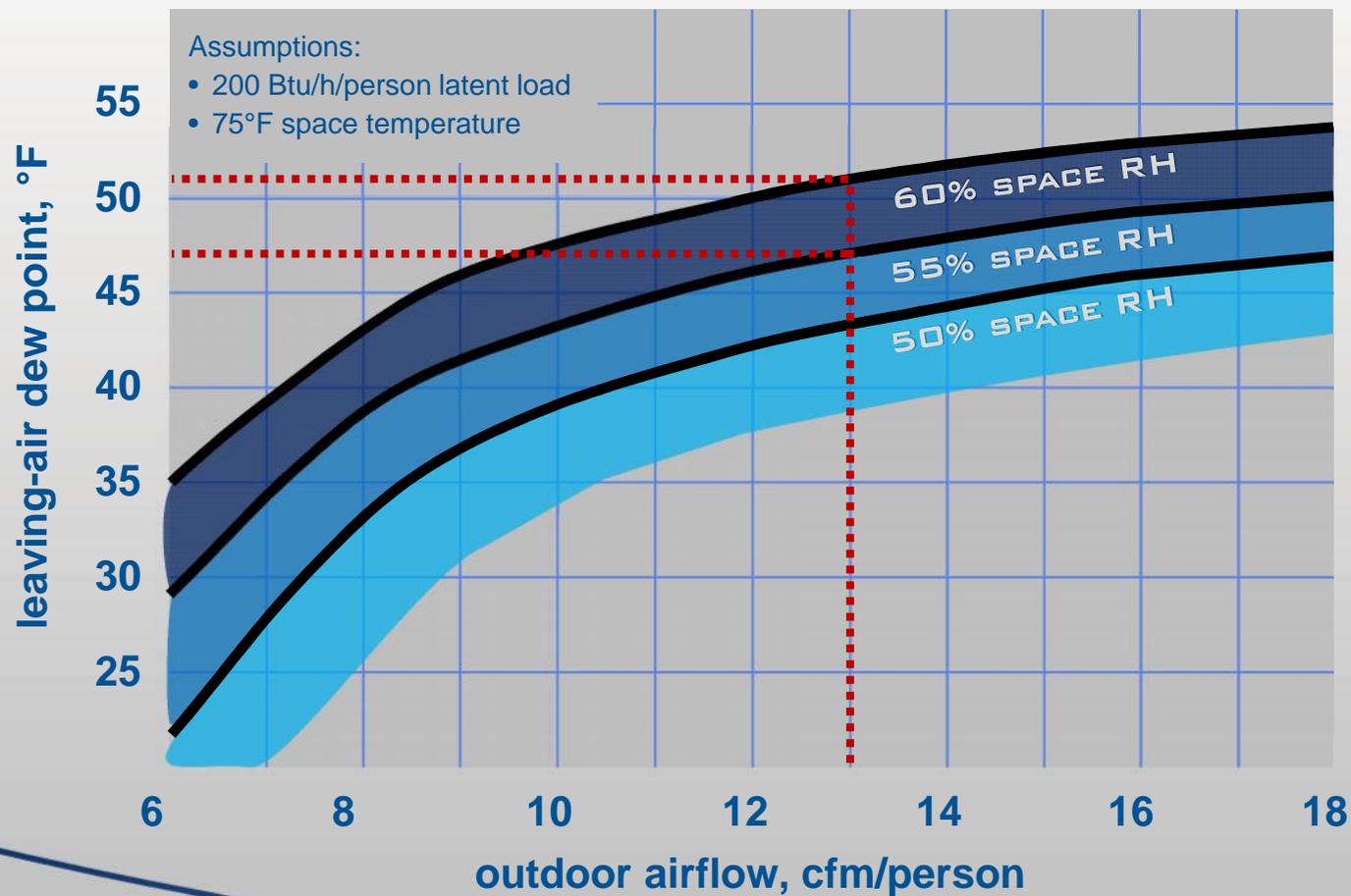
- Dedicated OA unit removes latent load due to ventilation
- Space latent loads must be removed by local units (any space dehumidification is coincidental)

Dehumidify Ventilation Air Only



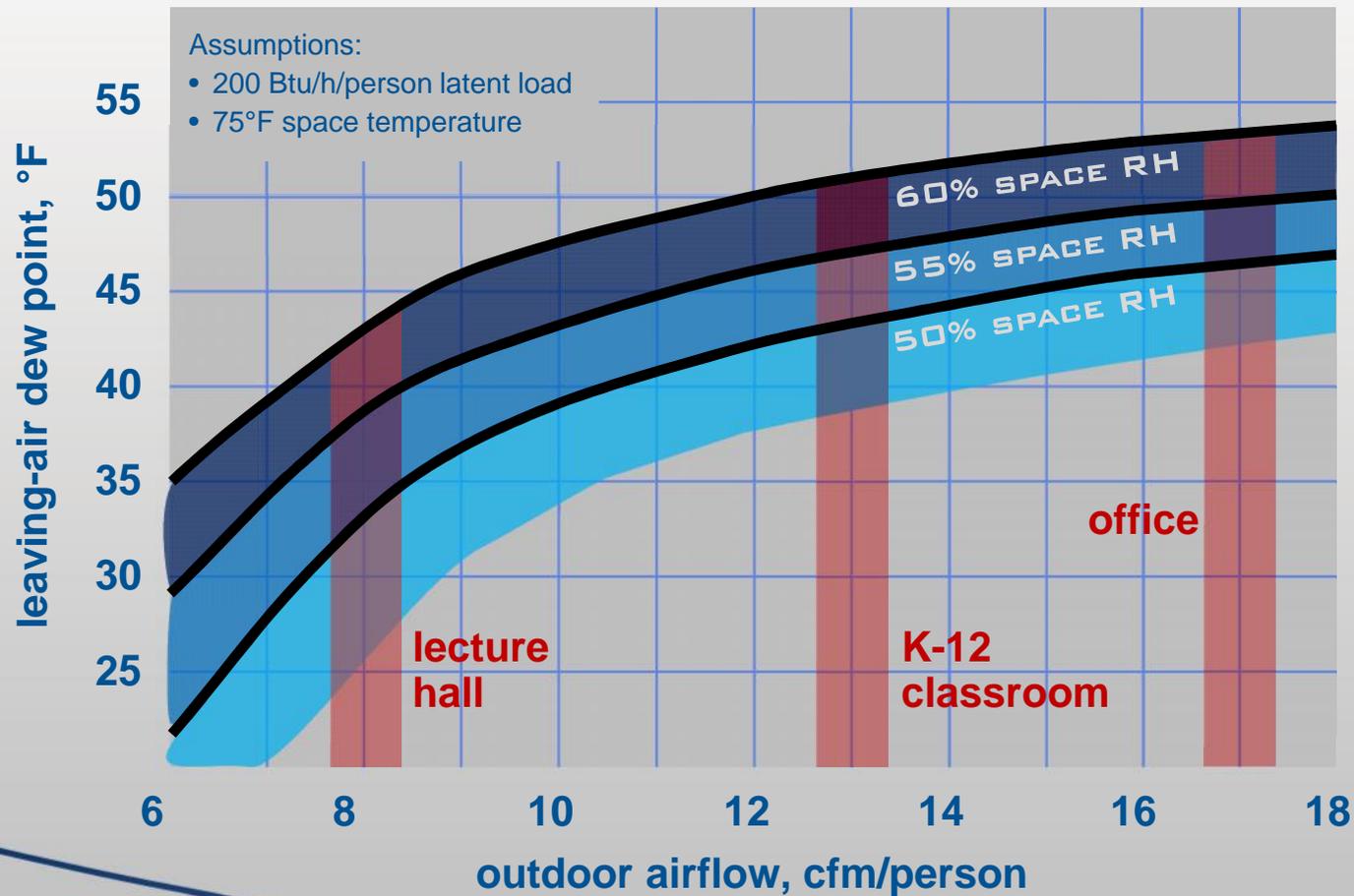
dehumidify the space (for comfort)

What Leaving-Air Dew Point is Required?



dehumidify the space (for comfort)

What Leaving-Air Dew Point is Required?



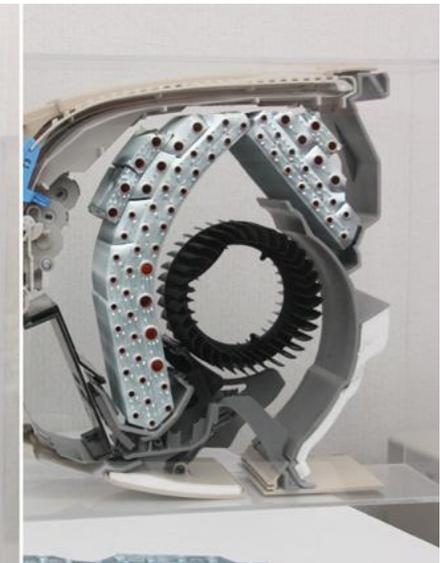
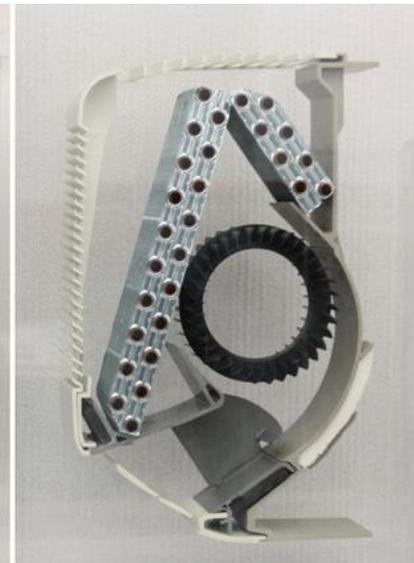
Capacidade Latente por tipo de Serpentina



A Capacidade de esfriamento Latente de sistemas de expansão direta e *menos* do que sistemas de Agua Gelada.

Temperaturas (ponto de orvalho) mais baixas e uniformes nos evaporadores.

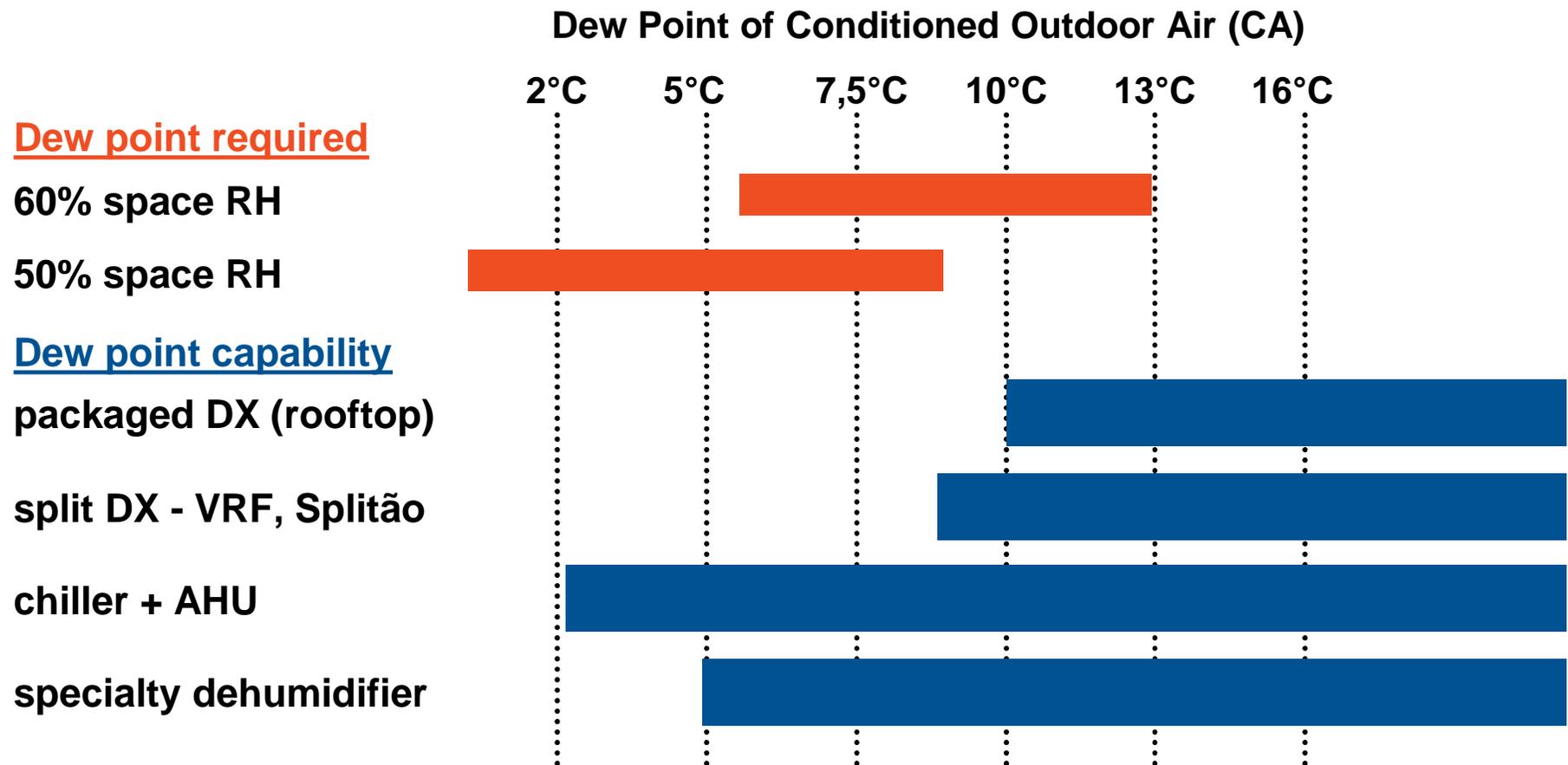
Serpentinas com mais area de troca



Capacidade Latente por tipo de Sistema – Temperatura Minima



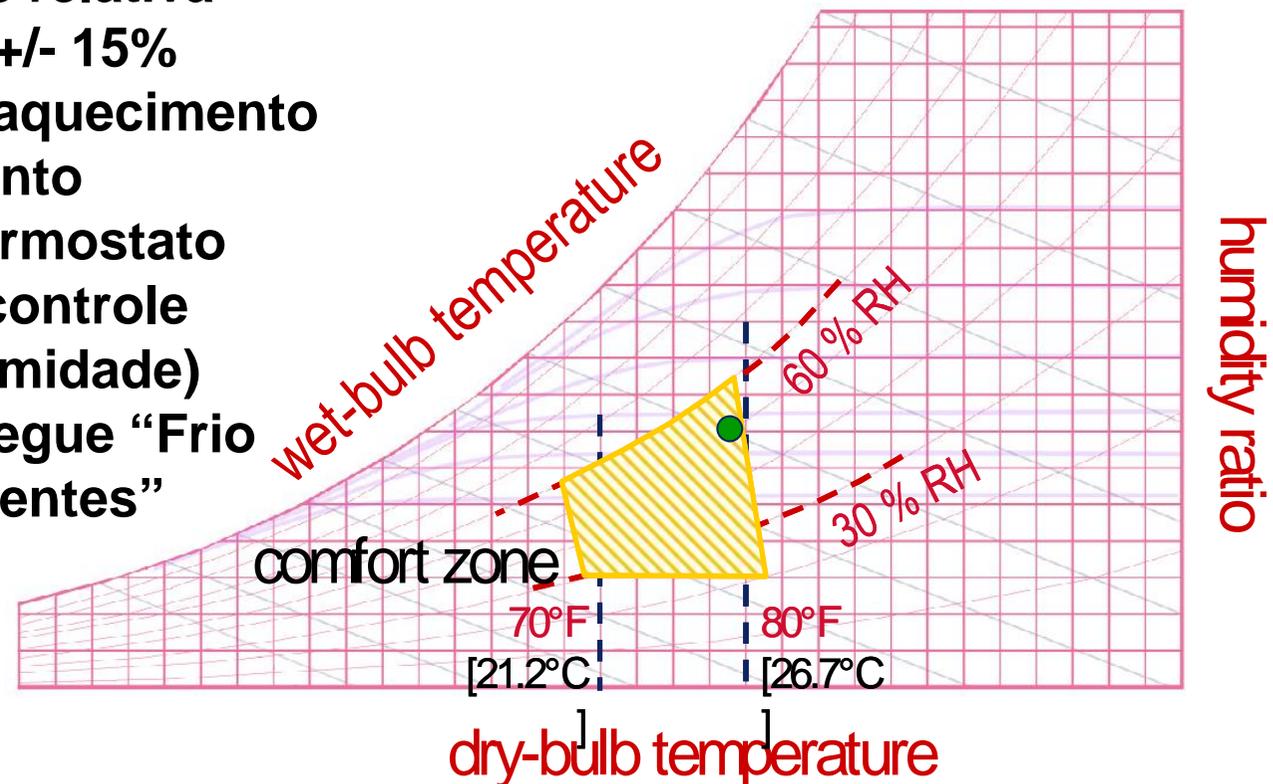
Considerando carga latente acima da media



Calculo Exemplo - Premissas

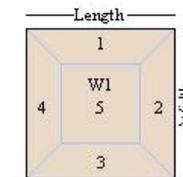
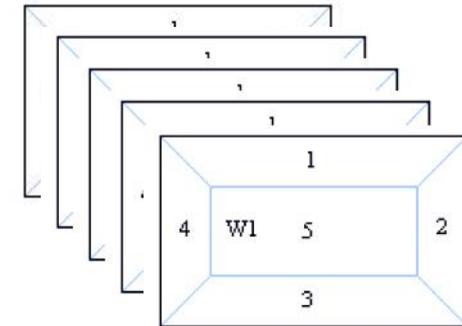
Criteria do Projeto:

- Tipo Escritorio – Media Densidade
- Manter temperatura (Tbs) nos ambientes em $24^{\circ}\text{C} \pm 2^{\circ}\text{C}$
- Manter umidade relativa (RH%) em $50\% \pm 15\%$
- Desconsiderar aquecimento ou re-aquecimento
- Controle por Termostato somente (sem controle *especifico* de Umidade)
- Ar Externa entregue “Frio direto aos ambientes”



Calculo Exemplo - Premissas

- **Materiais de construção conforme ASHRAE 90.1-2010 – Zona Climatica 2**
- **1800 m2 / andar (60 x 30m)**
- **5 Andares**
- **5 Ambientes x 5 Andares = 25 Ambientes**
- **1 Fan coil / Ambiente x 25 Ambientes = 25 Fan coils**
- **25% área envidraçada todas as faces**
- **FOCO – ambiente interna 864 m2, 32% Ar externa**



Wing name	Escrito	Percent Glass:	
Length	30 m	North	25 %
Width	60 m	East	25 %
Fir-to-flr height	4 m	South	25 %
Plenum height	0.5 m	West	25 %
No. of floors	5	Skylight	0 %
Perimeter depth	6 m		

Calculo Exemplo - Premissas



Tabela 1 — Vazão eficaz mínima de ar exterior para ventilação

Local	D pessoas/ 100 m ²	Nível 1		Nível 2		Nível 3		Exaustão mecânica L/s* m ^{2 a}
		F _p L/s* pess.	F _a L/s*m ²	F _p L/s* pess.	F _a L/s*m ²	F _p L/s* pess.	F _a L/s*m ²	
Edifícios de escritórios								
Hall do edifício, recepção	10	2,5	0,3	3,1	0,4	3,8	0,5	--
Escritórios de diretoria	6	2,5	0,3	3,1	0,4	3,8	0,5	--
Escritório com baixa densidade	11	2,5	0,3	3,1	0,4	3,8	0,5	--
Escritório com média densidade	14	2,5	0,3	3,1	0,4	3,8	0,5	--
Escritório com alta densidade	20	2,5	0,3	3,1	0,4	3,8	0,5	--
Sala de reunião	50	2,5	0,3	3,1	0,4	3,8	0,5	--
CPD (exceto impressoras)	4	2,5	0,3	3,1	0,4	3,8	0,5	--
Sala impressoras, copiadoras	--	--	--	--	--	--	--	2,5
Sala digitação	60	2,5	0,3	3,1	0,4	3,8	0,5	--
"Call center"	60	3,8	0,6	4,8	0,8	5,7	0,9	--

NORMA
BRASILEIRA

ABNT NBR
16401-3

Calculo Exemplo - Premissas



ANSI/ASHRAE/IES Standard 90.1-2010
 (Supersedes ANSI/ASHRAE/IESNA Standard 90.1-2007)
 Includes ANSI/ASHRAE/IES Addenda listed in Appendix F

ASHRAE STANDARD

TABLE 5.5-2 Building Envelope Requirements for Climate Zone 2 (A, B)*

Opaque Elements	Nonresidential		Residential		Sen
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	
<i>Roofs</i>					
Insulation Entirely above Deck	U-0.273	R-3.5 c.i.	U-0.273	R-3.5 c.i.	U-1.240
Metal Building ^a	U-0.312	R-2.3+R-2.3	U-0.312	R-2.3+R-2.3	U-0.551
Attic and Other	U-0.153	R-6.7	U-0.153	R-6.7	U-0.459
<i>Walls, Above-Grade</i>					
Mass	U-0.857 ^b	R-1.0 c.i. ^b	U-0.701 ^b	R-1.3 c.i. ^b	U-3.293
Metal Building	U-0.528	R-2.8	U-0.528	R-2.8	U-1.045
Steel-Framed	U-0.705	R-2.3	U-0.365	R-2.3 + R-1.3 c.i.	U-0.705
Wood-Framed and Other	U-0.504	R-2.3	U-0.504	R-2.3	U-0.504
<i>Walls, Below-Grade</i>					
Below-Grade Wall	C-6.473	NR	C-6.473	NR	C-6.473
<i>Floors</i>					
Mass	U-0.606	R-1.1 c.i.	U-0.496	R-1.5 c.i.	U-1.825
Steel-Joist	U-0.296	R-3.3	U-0.296	R-3.3	U-0.390
Wood-Framed and Other	U-0.288	R-3.3	U-0.188	R-5.3	U-0.376

Resultados do Calculo – Zona Interna 1 – sem DOAS



COOLING COIL PEAK				
Peaked at Time:		Mo/Hr: 3 / 15		
Outside Air:		OADB/WB/HR: 31 / 25 / 18		
	Space Sens. + Lat. kW	Plenum Sens. + Lat. kW	Net Total kW	Percent Of Total (%)
Envelope Loads				
Skylite Solar	0.00	0.00	0.00	0.00
Skylite Cond	0.00	0.00	0.00	0.00
Roof Cond	0.00	5.34	5.34	7.03
Glass Solar	0.00	0.00	0.00	0.00
Glass/Door Cond	0.00	0.00	0.00	0.00
Wall Cond	0.00	0.00	0.00	0.00
Partition/Door	0.00	0.00	0.00	0.00
Floor	0.00	0.00	0.00	0.00
Adjacent Floor	0	0	0	0
Infiltration	15.10	0.00	15.10	19.88
Sub Total ==>	15.10	5.34	20.44	26.92
Internal Loads				
Lights	6.48	6.48	12.96	17.07
People	14.40	0.00	14.40	18.96
Misc	8.64	0.00	8.64	11.38
Sub Total ==>	29.52	6.48	36.00	47.41
Ceiling Load	2.14	-2.14	0.00	0.00
Ventilation Load	0.00	0.00	21.61	28.46
Adj Air Trans Heat	0	0	0	0
Dehumid. Ov Sizing	0.00	0.00	0.00	0.00
Ov/Undr Sizing	0.00	0.00	0.00	0.00
Exhaust Heat	0.00	-2.11	-2.11	-2.78
Sup. Fan Heat	0.00	0.00	0.00	0.00
Ret. Fan Heat	0.00	0.00	0.00	0.00
Duct Heat Pkup	0.00	0.00	0.00	0.00
Underflr Sup Ht Pkup	0	0	0	0
Supply Air Leakage	0	0	0	0
Grand Total ==>	46.76	7.57	75.94	100.00



COOLING COIL SELEC						
	Total Capacity kW	Sens Cap. kW	Coil Airflow L/s	Leave DB/WB/HR °C °C g/kg		
Main Clg	75.94	43.73	2,208	12.8	11.8	8.2
Aux Clg	0.00	0.00	0	0.0	0.0	0.0
Opt Vent	0.00	0.00	0	0.0	0.0	0.0
Total	75.94					

Resultados do Calculo - Zona Interna 1 – com DOAS



Escrito - Interior 1

COOLING COIL PEAK				
Peaked at Time:		Mo/Hr: 2 / 15		
Outside Air:		OADB/WB/HR: 32 / 25 / 18		
	Space Sens. + Lat. kW	Plenum Sens. + Lat. kW	Net Total kW	Percent Of Total (%)
Envelope Loads				
Skylite Solar	0.00	0.00	0.00	0.00
Skylite Cond	0.00	0.00	0.00	0.00
Roof Cond	0.00	5.49	5.49	14.73
Glass Solar	0.00	0.00	0.00	0.00
Glass/Door Cond	0.00	0.00	0.00	0.00
Wall Cond	0.00	0.00	0.00	0.00
Partition/Door	0.00	0.00	0.00	0.00
Floor	0.00	0.00	0.00	0.00
Adjacent Floor	0	0	0	0
Infiltration	14.51	0.00	14.51	38.93
Sub Total ==>	14.51	5.49	20.00	53.66
Internal Loads				
Lights	6.48	6.48	12.96	34.77
People	14.40	0.00	14.40	38.64
Misc	8.64	0.00	8.64	23.18
Sub Total ==>	29.52	6.48	36.00	96.59
Ceiling Load	2.16	-2.16	0.00	0.00
Ventilation Load	-17.03	0.00	-17.03	-45.69
Adj Air Trans Heat	0	0	0	0
Dehumid. Ov Sizing	0.00	0.00	0.00	0.00
Ov/Undr Sizing	0.00	0.00	0.00	0.00
Exhaust Heat	0.00	-2.12	-2.12	-5.69
Sup. Fan Heat	0.00	0.42	0.42	1.13
Ret. Fan Heat	0.00	0.00	0.00	0.00
Duct Heat Pkup	0.00	0.00	0.00	0.00
Underflr Sup Ht Pkup	0.00	0.00	0.00	0.00
Supply Air Leakage	0.00	0.00	0.00	0.00
Grand Total ==>	29.16	7.69	37.27	100.00

COOLING COIL SELEC						
	Total Capacity kW	Sens Cap. kW	Coil Airflow L/s	Leave DB/WB/HR °C °C g/kg		
Main Clg	37.28	27.17	1,436	12.8	11.9	8.4
Aux Clg	0.00	0.00	0	0.0	0.0	0.0
Opt Vent	38.59	17.71	721	12.0	12.0	8.7
Total	75.87					



Zona Interna 1 – Sem x Com DOAS



COOLING COIL SELEC						
	Total Capacity kW	Sens Cap. kW	Coil Airflow L/s	Leave DB/WB/HR °C °C g/kg		
Main Clg	37.28	27.17	1,436	12.8	11.9	8.4
Aux Clg	0.00	0.00	0	0.0	0.0	0.0
Opt Vent	38.59	17.71	721	12.0	12.0	8.7
Total	75.87					

COOLING COIL SELEC						
	Total Capacity kW	Sens Cap. kW	Coil Airflow L/s	Leave DB/WB/HR °C °C g/kg		
Main Clg	75.94	43.73	2,208	12.8	11.8	8.2
Aux Clg	0.00	0.00	0	0.0	0.0	0.0
Opt Vent	0.00	0.00	0	0.0	0.0	0.0
Total	75.94					

Seleção de Serpentina - Zona Interna 1 – sem DOAS



Coil Location	Cooling Coil Selection											
	Room	Component	Time Of Peak Mo/Hr	Total Capacity kW		Sensible Capacity kW	Airflow At Coil Peak L/s	Enter DB/ WB/ HR °C °C g/kg			Leave DB/ WB/ HR °C °C g/kg	
Escrito - Interior	Main Clg Coil	3/15	287.8	287.8	158.9	8,832	27.3	21.3	13.5	12.8	12.4	8.8
Escrito - Interior 1	Main Clg Coil	3/15	75.9	75.9	43.7	2,208	27.3	21.3	13.5	12.8	11.8	8.2
Escrito - Leste	Main Clg Coil	2/11	164.3	164.3	119.5	7,255	25.8	18.4	10.2	12.4	11.7	8.3
Escrito - Leste 1	Main Clg Coil	2/11	42.2	42.2	31.0	1,814	25.8	18.4	10.2	12.4	11.5	8.1
Escrito - Norte	Main Clg Coil	5/15	75.3	75.3	50.0	2,931	26.3	18.9	10.7	12.0	11.3	8.1
E:											11.1	7.8
E:											11.5	8.2

Int 1 Ftlza 1

General

Unit:	Wave Doble Std (Forward-curved Fan)	Mixing Box Air Pressure Drop:	3.90 mm H2O
Unit Size:	4400 to 8000 m ³ /h	Air Filter Coil Module:	Throwaway 1" G4 (Std)
Modules:	(T) Std. Mixing Box, Coil & Fan	Filter Air Pressure Drop:	4.99 mm H2O
Cabinet Configuration / Air Discharge:	Horizontal / Horizontal	Air Filter - Final Filter Module:	w/o Filter / Not Applicable
Cabinet Effect Loss:	12.90 mm H2O	Elevation:	800.0 m
E:			11.5
E:			8.3
E:			11.2
E:			8.0

Coil

Row Options:	6 rows	Cooling Leaving Water Temperature:	12.0 C
Tube Diameter:	1/2"	Cooling Water Flow Rate:	9.38 m ³ /hr
Material Type:	Standard	Cooling Water Volume:	21.23 L
Fin Options:	120 FPF	Cooling Water Velocity:	2.2 m/s
Circuit:	P1/2	Cooling Water Pressure Drop:	10009.08 mm H2O
Cooling Airflow:	2208.0 L/s	Cooling Air Pressure Drop:	21.47 mm H2O
Cooling Capacity:	51.68 kW	Cooling Coil Wet Weight:	221 kg
Sensible Capacity:	32.40 kW	Actual Cooling Face Velocity:	3.0 m/s
Cooling Entering Dry Bulb:	25.5 C	Fluid Type:	Water
Cooling Entering Wet Bulb:	19.4 C	Water Connection:	BSP
Cooling Leaving Dry Bulb:	13.6 C	Water Connection Side:	Right Side
Cooling Leaving Wet Bulb:	12.6 C	Heat Options:	w/o Heat / Not Applicable
Cooling Entering Water Temperature:	7.0 C		

Seleção de Serpentina - Zona Interna 1 – com DOAS



Coil Location		Cooling Coil Selection										
Room	Component	Time Of Peak Mo/Hr	Total Capacity kW		Sensible Capacity kW	Airflow At Coil Peak L/s	Enter DB/ WB/ HR °C °C g/kg			Leave DB/ WB/ HR °C °C g/kg		
CX de Mistura	Optional Vent Clg Coil	3/15	401.9	401.9	184.5	7,513	31.7	25.4	18.0	12.0	12.0	8.7
Escrito - Interior	Main Clg Coil	3/15	133.0	133.0	90.6	5,743	25.5	19.4	11.6	12.8	12.8	9.2
Escrito - Interior 1	Main Clg Coil	2/15	37.3	37.3	27.2	1,436	25.5	19.4	11.6	12.8	11.9	8.4
Escrito - Leste	Main Clg Coil	2/11	120.4	120.4	97.6	6,296	25.4	17.5	9.3	12.7	11.7	8.2
Escrito - Leste 1	Main Clg Coil	2/11	31.2	31.2	25.5	1,574	25.4	17.5	9.3	12.7	11.5	8.0
Escrito - Norte	Main Clg Coil	5/15	51.5	51.5	39.1	2,475	25.5	17.5	9.3	12.1	11.2	7.9
Escrito - I											0.9	7.6
Escrito - (11.6	8.2
Escrito - (11.3	7.9
Escrito - (11.2	8.0
Escrito - (0.9	7.7
Int 1 Ftza 2												
General												
Unit:	Wave Doble Std (Forward-curved Fan)		Mixing Box Air Pressure Drop:			0.00 mm H2O						
Unit Size:	3000 to 6000 m3/h		Air Filter Coil Module:			Throwaway 1" G4 (Std)						
Modules:	(P) Coil & Fan		Filter Air Pressure Drop:			3.78 mm H2O						
Cabinet Configuration / Air Discharge:	Horizontal / horizontal		Air Filter - Final Filter Module:			w/o Filter / Not Applicable						
Cabinet Effect Loss:	8.69 mm H2O		Elevation:			800.0 m						
Coil												
Row Options:	8 rows		Cooling Leaving Water Temperature:			12.0 C						
Tube Diameter:	1/2"		Cooling Water Flow Rate:			6.57 m3/hr						
Material Type:	Standard		Cooling Water Volume:			21.98 L						
Fin Options:	120 FPF		Cooling Water Velocity:			0.8 m/s						
Circuit:	W		Cooling Water Pressure Drop:			1045.45 mm H2O						
Cooling Airflow:	1436.0 L/s		Cooling Air Pressure Drop:			22.31 mm H2O						
Cooling Capacity:	36.77 kW		Cooling Coil Wet Weight:			272 kg						
Sensible Capacity:	23.01 kW		Actual Cooling Face Velocity:			2.5 m/s						
Cooling Entering Dry Bulb:	25.5 C		Fluid Type:			Water						
Cooling Entering Wet Bulb:	19.4 C		Water Connection:			BSP						
Cooling Leaving Dry Bulb:	12.5 C		Water Connection Side:			Right Side						
Cooling Leaving Wet Bulb:	11.9 C		Heat Options:			w/o Heat / Not Applicable						
Cooling Entering Water Temperature:	7.0 C											

Características dos Fan Coils

- Referencia: Trane WAVE Double
- Serpentina - 120 FPF
- Atender carga sensível e latente conforme calcula de carga utilizando o mínimo de rows (filas) possível
- Minimizar queda de pressão de agua e ar nas serpentinas
- Horizontal
- 20 mmHG pressão externa rede de dutos
- Aproximação (approach) entre temperatura de agua gelada e saída de ar = 5°C
- Ventilador volume constante
- **Filas (rows) adicionais aumenta custo inicial do produto de 6% a 10% por cada 2 rows (geralmente 4, 6 ou 8 rows)**
- **Adição de Caixa de Mistura em Fan coils aumenta custo inicial +/-20%**

QAI – controle de Umidade



Occupied hours only - Alternative 1

System/Room Description	--- Maximum---				----- Number of Hours at each Percentage Range -----									
	%Rh	Mo	Hr	Day	>70%	70-66	66-62	62-58	58-54	54-50	50-46	46-42	42-38	:
Sem DOAS														
Fan Coils - OA na CX de Mistura														
Escrito - Interior	66	2	12	Sat	0	30	171	1,840	1,606	103	0	0	0	
Escrito - Interior 1	66	4	12	Sat	0	25	170	1,349	2,060	146	0	0	0	
Escrito - Leste	69	5	21	Wkdy	0	573	955	1,170	736	237	79	0	0	
Escrito - Leste 1	69	5	21	Wkdy	0	501	1,018	1,134	743	244	110	0	0	
Escrito - Norte	69	3	12	Sat	0	242	1,325	1,395	476	203	109	0	0	
Escrito - Norte 1	70	3	12	Sat	4	236	1,248	1,451	495	203	113	0	0	
Escrito - Oeste	71	5	12	Sat	26	526	1,641	1,122	274	161	0	0	0	
Escrito - Oeste 1	72	5	12	Sat	26	505	1,615	1,165	270	169	0	0	0	
Escrito - Sul	70	5	12	Sat	9	287	1,468	1,064	702	104	116	0	0	
Escrito - Sul 1	70	5	12	Sat	13	318	1,408	1,031	746	106	128	0	0	

Occupied hours only - Alternative 2

System/Room Description	--- Maximum---				----- Number of Hours at each Percentage Range -----									
	%Rh	Mo	Hr	Day	>70%	70-66	66-62	62-58	58-54	54-50	50-46	46-42	42-38	38-34
Com DOAS														
Fan Coils - OA na CX de Mistura														
Escrito - Interior	64	11	8	Mon	0	0	17	268	2,849	616	0	0	0	
Escrito - Interior 1	62	12	8	Mon	0	0	7	141	2,821	781	0	0	0	
Escrito - Leste	55	5	18	Dsgn	0	0	0	0	190	3,352	208	0	0	
Escrito - Leste 1	55	5	18	Dsgn	0	0	0	0	189	3,215	346	0	0	
Escrito - Norte	56	11	8	Mon	0	0	0	0	412	2,445	893	0	0	
Escrito - Norte 1	56	11	8	Mon	0	0	0	0	370	2,417	963	0	0	
Escrito - Oeste	55	3	11	Dsgn	0	0	0	0	298	2,904	548	0	0	
Escrito - Oeste 1	55	3	11	Dsgn	0	0	0	0	275	2,901	574	0	0	
Escrito - Sul	56	9	8	Mon	0	0	0	0	257	3,062	431	0	0	
Escrito - Sul 1	55	9	8	Mon	0	0	0	0	222	2,992	536	0	0	

Benefícios de DOAS



- **Custo inicial (impacto no TR total instalado)**
- **Desacoplamento da carga Latente e carga sensível**
- **Custo operacional**
- **Ciclo economizador, recuperação de energia (requisitos da ASHRAE 90.1 quanto uso dos mesmos no Brasil)**
- **Qualidade de ar interna**
- **Aquecimento suplementar para pequenas demandas**
- **Controle de ventilação por demanda**
- **Pressurização do prédio**
- **Diluir ou elimina contaminantes**
- **Filtragem**
- **Uso de dessicantes**

Conclusão



- **Em aplicações com cargas latentes mais elevadas, é possível aplicar DOAS para o mesmo custo, OU menor de um sistema sem DOAS**
- **...e conseguir um Qualidade da Ar Interna superior**
- **25 FCUs convencionais com caixas de misturas e mais rows**
- **25 FCUs convencionais *sem* caixas de misturas e menos rows + 3 FCUs tipo DOAS.**

Want to Learn More?



- www.trane.com/bookstore
 - *Systems Manual, Air Conditioning Clinic series, Engineers Newsletter*
 - New application manual available 1Q 2002
- ***Designing Dedicated Outdoor-Air Ventilation Systems***
(Trane engineering bulletin SYS-EB-3)
- **Murphy, J. 2006. “Smart Dedicated Outdoor Air Systems.”**
ASHRAE Journal (July)
- **“Dedicated Outdoor-Air Ventilation Systems”** *Engineers Newsletter Live* broadcast, APP-CMC008-EN (2001)
- **"Designing Dedicated Outdoor-Air Systems,"** Trane application guide
SYS-APG001-EN (2003)
- **"Dedicated Ventilation Systems,"** *Engineers Newsletter* 30-3 (2001)
- **Morris, W. 2003. “The ABCs of DOAS: Dedicated Outdoor Air Systems.”** *ASHRAE Journal* (May)

References



- **www.trane.com/bookstore**
 - *Systems Manual, Air Conditioning Clinic series, Engineers Newsletter*
 - New application manual available 1Q 2002
- ***Designing Dedicated Outdoor-Air Ventilation Systems***
(Trane engineering bulletin SYS-EB-3)
- **Bibliography**
- **Apresentação – 3º QAI, Maio 2014 “Suggestions for Better Buildings in Hot & Humid Climates” – Lew Harriman, Manson-Grant Consulting**
- **Seminário Sistemas de Água Gelada – 24/02/16 - “RESFRIAMENTO DEDICADO DE AR EXTERNO (DOAS)” - Cristiano Rayer Brasil**
- **Seminário Sistemas de Água Gelada – 01/04/16 - “DOAS – Sistemas de Resfriamento de Ar Externo” - Luciano de A Marcato**

SISTEMAS DE ÁGUA GELADA



PROGRAMA
BRASILEIRO DE
ELIMINAÇÃO DOS

HCFCs
Projeto para o Encerramento de CILIBers

Apoio Institucional:



Execução



Implementação



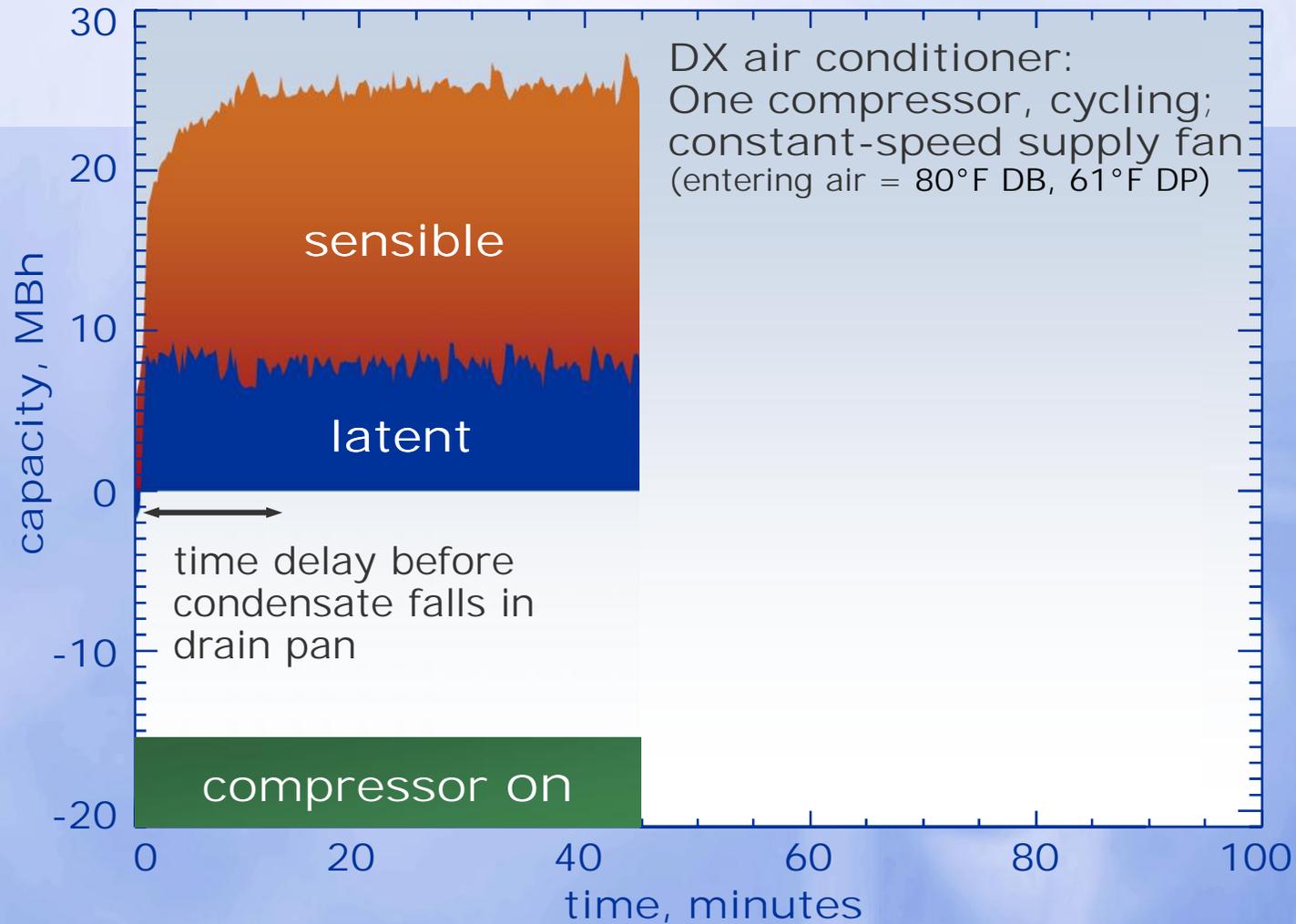
Empoderando vidas.
Fortalecendo nações.

Realização

Ministério do
Meio Ambiente

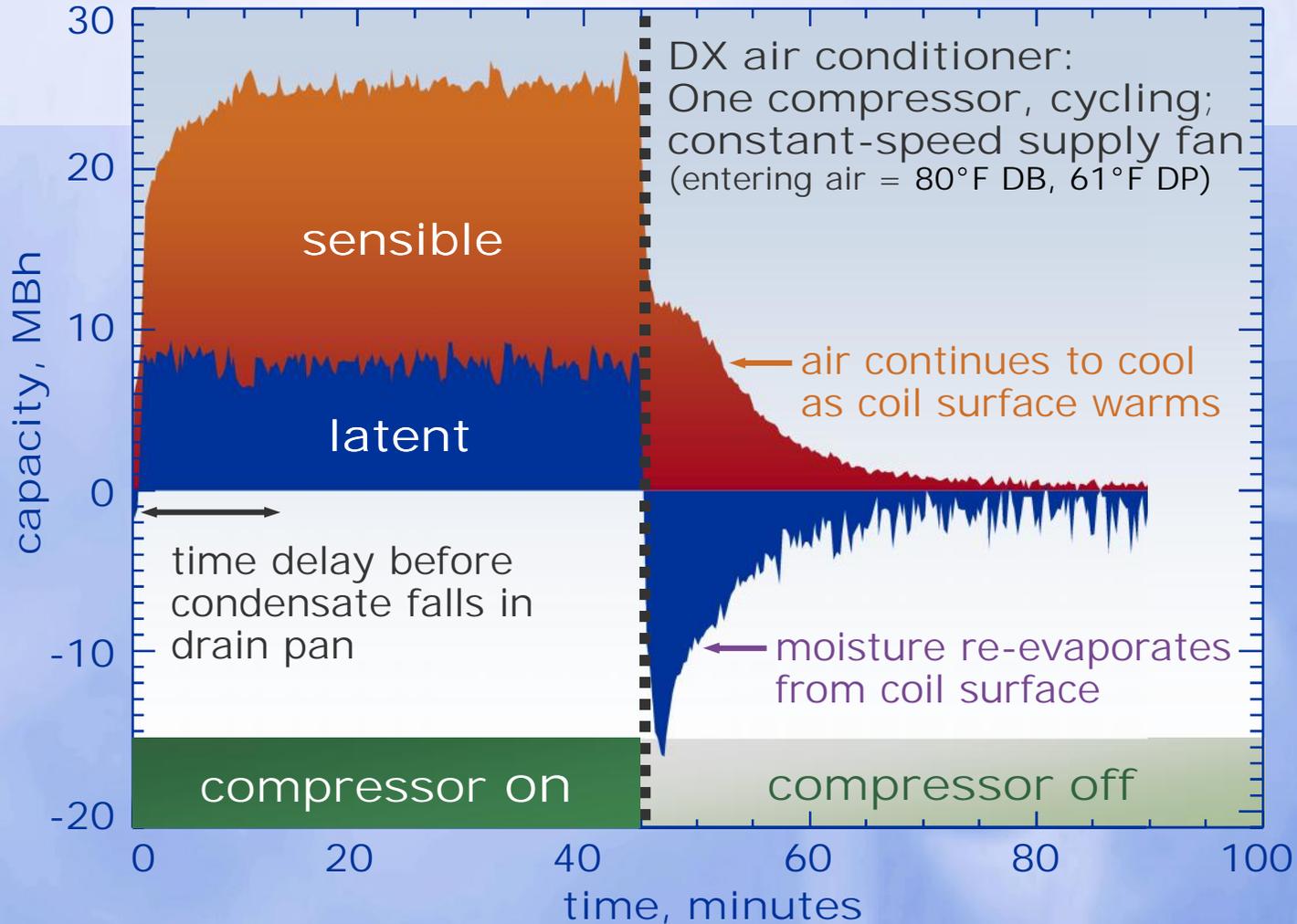


Cooling-Coil Dehumidification



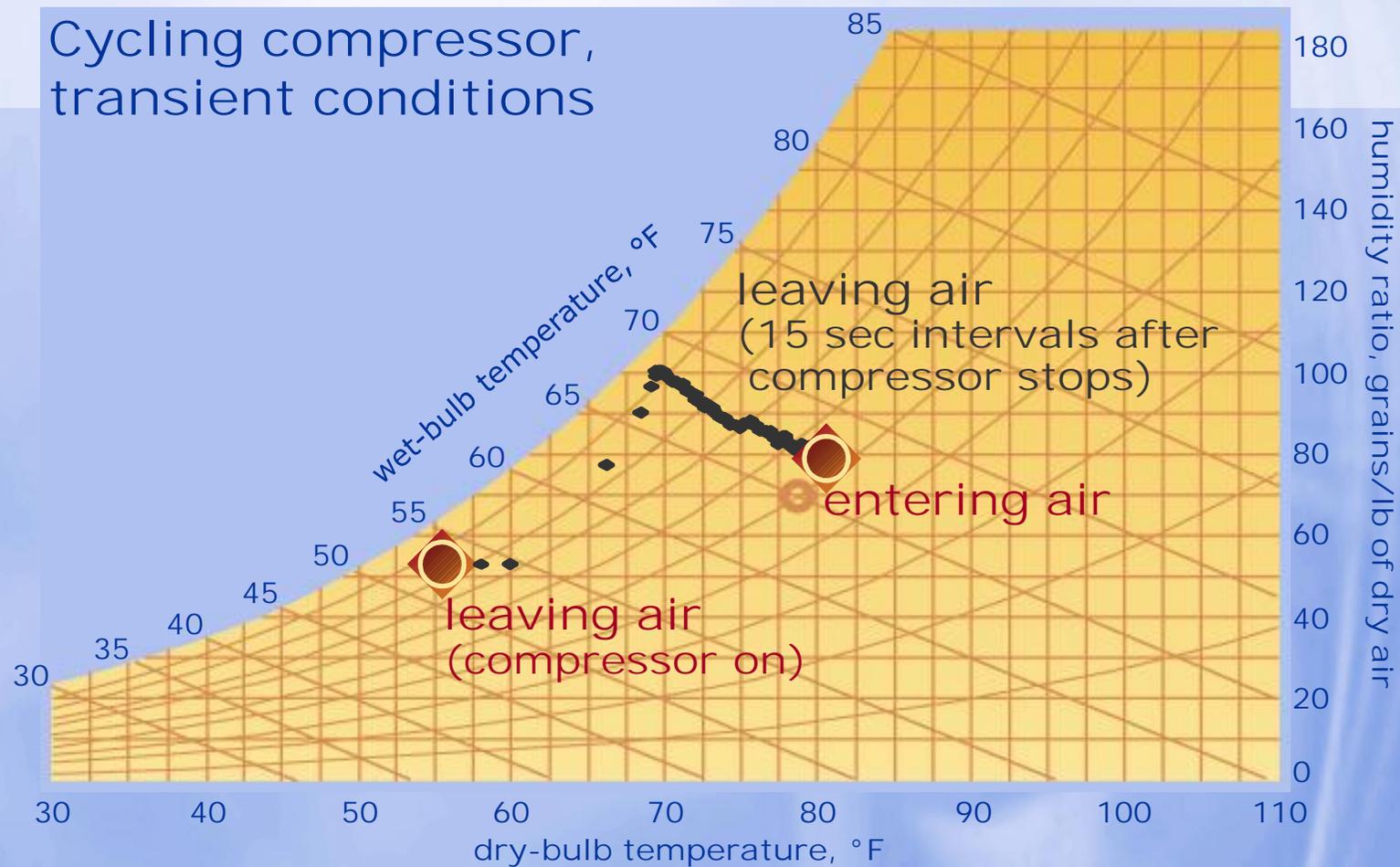
Shirey, D., H. Henderson, and R. Raustad. 2003. DOE/NETL Project #DE-FC26-01NT41253

Cooling-Coil Dehumidification



Shirey, D., H. Henderson, and R. Raustad. 2003. DOE/NETL Project #DE-FC26-01NT41253

Cycling compressor, transient conditions



16

Should there be a title in orange on all the graph slides?

lyang, 04/09/2007



Coil Location		Cooling Coil Selection										
Room	Component	Time Of Peak Mo/Hr	Total Capacity		Sensible Capacity kW	Airflow At Coil Peak L/s	Enter DB/ WB/ HR			Leave DB/ WB/ HR		
			kW	kW			°C	°C	g/kg	°C	°C	g/kg
CX de Mistura	Optional Vent Clg Coil	3/15	401.9	401.9	184.5	7,513	31.7	25.4	18.0	12.0	12.0	8.7
Escrito - Interior	Main Clg Coil	3/15	133.0	133.0	90.6	5,743	25.5	19.4	11.6	12.8	12.8	9.2
Escrito - Interior 1	Main Clg Coil	2/15	37.3	37.3	27.2	1,436	25.5	19.4	11.6	12.8	11.9	8.4
Escrito - Leste	Main Clg Coil	2/11	120.4	120.4	97.6	6,296	25.4	17.5	9.3	12.7	11.7	8.2
Escrito - Leste 1	Main Clg Coil	2/11	31.2	31.2	25.5	1,574	25.4	17.5	9.3	12.7	11.5	8.0
Escrito - Norte	Main Clg Coil	5/15	51.5	51.5	39.1	2,475	25.5	17.5	9.3	12.1	11.2	7.9
Escrito - Norte 1	Main Clg Coil	5/15	13.5	13.5	10.4	619	25.5	17.5	9.3	12.1	10.9	7.6
Escrito - Oeste	Main Clg Coil	2/17	134.4	134.3	107.6	6,837	25.5	17.5	9.3	12.4	11.6	8.2
Escrito - Oeste 1	Main Clg Coil	2/17	34.8	34.8	28.1	1,709	25.5	17.5	9.3	12.4	11.3	7.9
Escrito - Sul	Main Clg Coil	12/15	50.5	50.5	39.0	2,363	25.5	17.7	9.5	12.0	11.2	8.0
Escrito - Sul 1	Main Clg Coil	12/15	13.2	13.2	10.3	591	25.5	17.7	9.5	12.0	10.9	7.7

DOAS Ftlz 1d3

General

Unit:	Wave Doble Std (Forward-curved Fan)	Mixing Box Air Pressure Drop:	2.34 mm H2O
Unit Size:	6000 to 12000 m3/h	Air Filter Coil Module:	Throwaway 1" G4 (Std)
Modules:	(T) Std. Mixing Box, Coil & Fan	Filter Air Pressure Drop:	2.69 mm H2O
Cabinet Configuration / Air Discharge:	Horizontal / Horizontal	Air Filter - Final Filter Module:	w/o Filter / Not Applicable
Cabinet Effect Loss:	6.85 mm H2O	Elevation:	0.0 m

Coil

Row Options:	8 rows	Cooling Leaving Water Temperature:	12.0 C
Tube Diameter:	1/2"	Cooling Water Flow Rate:	23.18 m3/hr
Material Type:	Standard	Cooling Water Volume:	41.73 L
Fin Options:	120 FPF	Cooling Water Velocity:	1.9 m/s
Circuit:	W	Cooling Water Pressure Drop:	6867.67 mm H2O
Cooling Airflow:	2500.0 L/s	Cooling Air Pressure Drop:	19.96 mm H2O
Cooling Capacity:	132.11 kW	Cooling Coil Wet Weight:	411 kg
Sensible Capacity:	60.01 kW	Actual Cooling Face Velocity:	2.3 m/s
Cooling Entering Dry Bulb:	31.7 C	Fluid Type:	Water
Cooling Entering Wet Bulb:	25.4 C	Water Connection:	BSP
Cooling Leaving Dry Bulb:	12.5 C	Water Connection Side:	Right Side
Cooling Leaving Wet Bulb:	11.8 C	Heat Options:	w/o Heat / Not Applicable
Cooling Entering Water Temperature:	7.0 C		