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EPX Heat Exchanger Technology for Dry Evaporative Cooling

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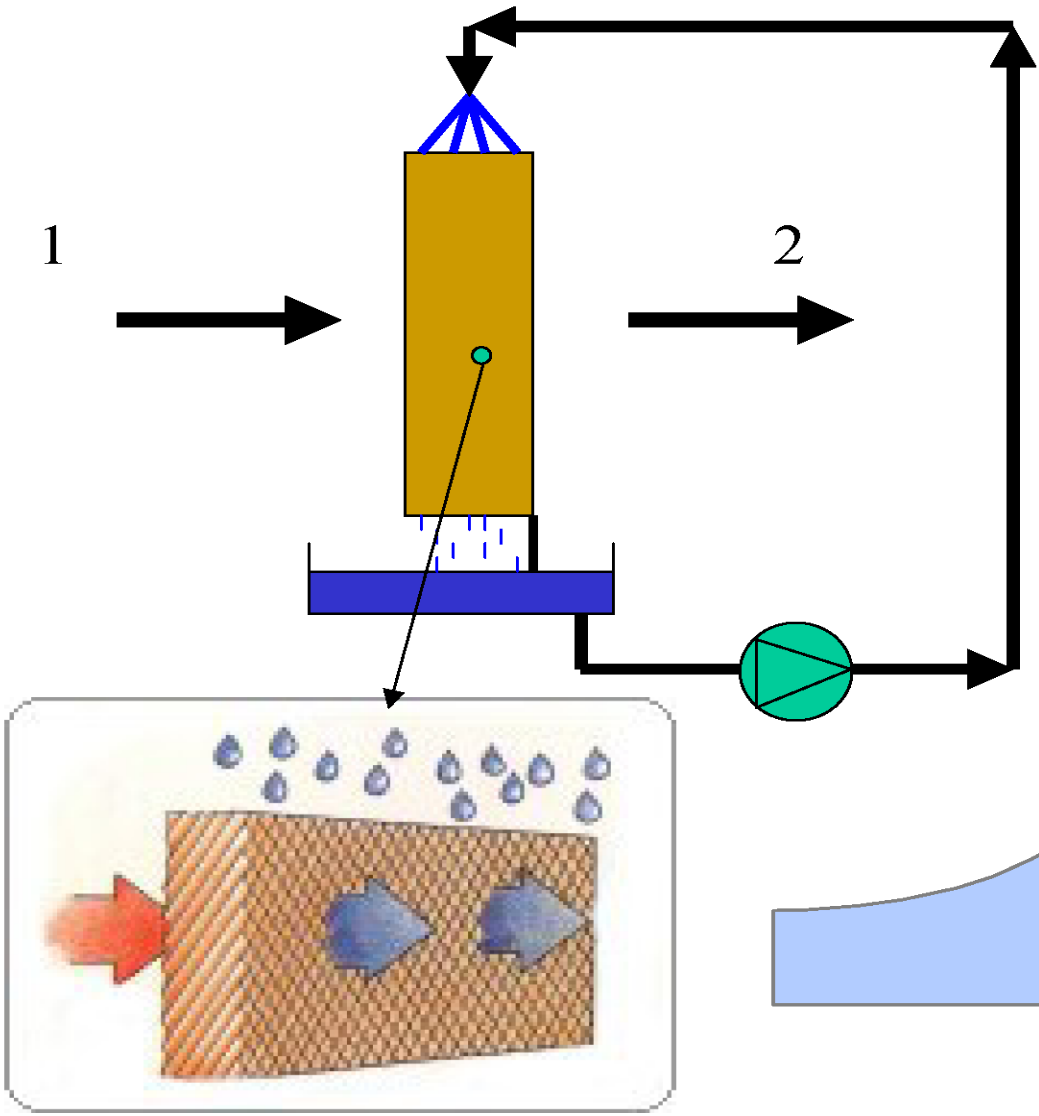
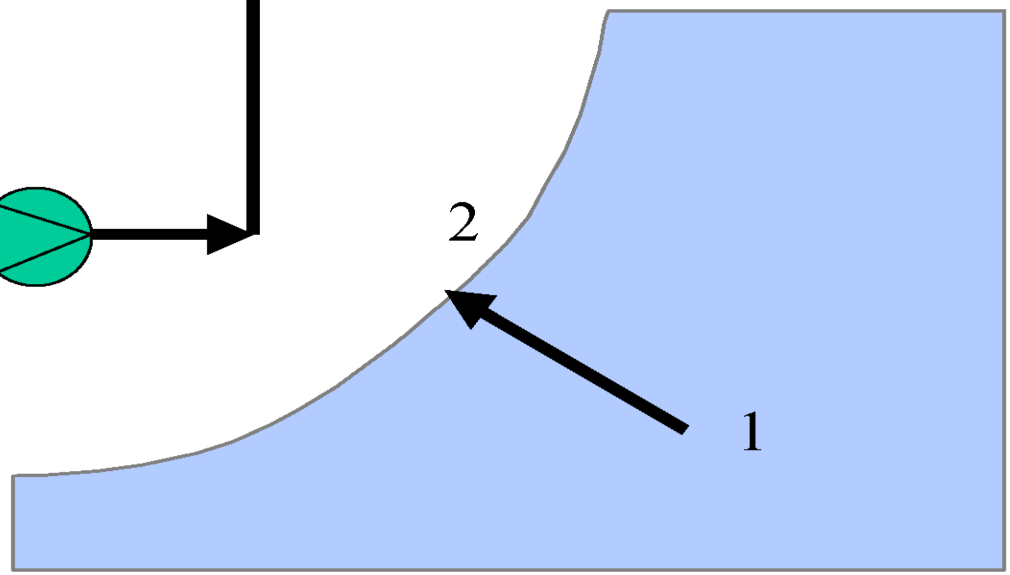
DIRECT EVAPORATIVE COOLING … A CONSTANT WET BULB PROCESS

HUMIDIFIES AND COOLS





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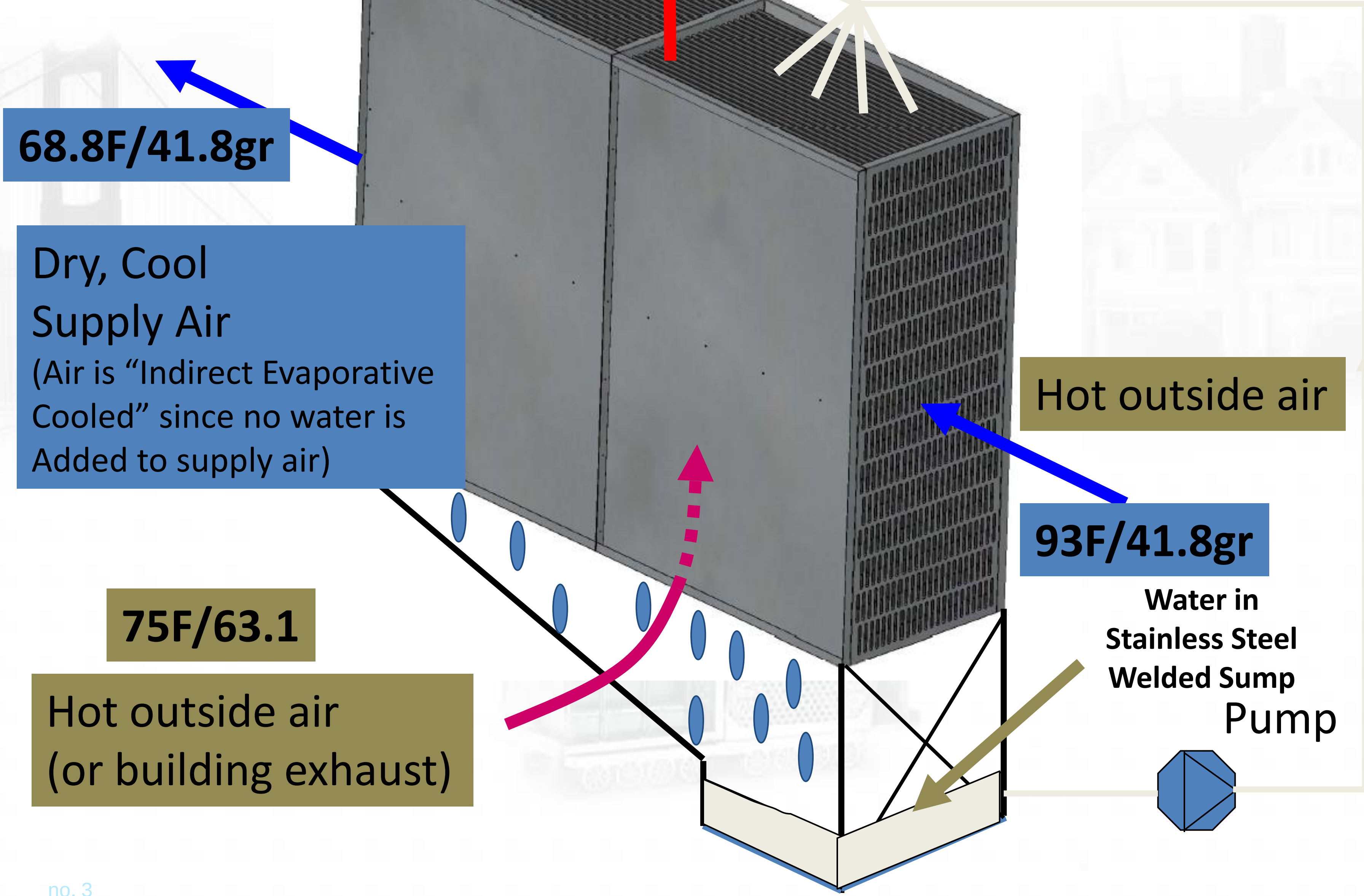

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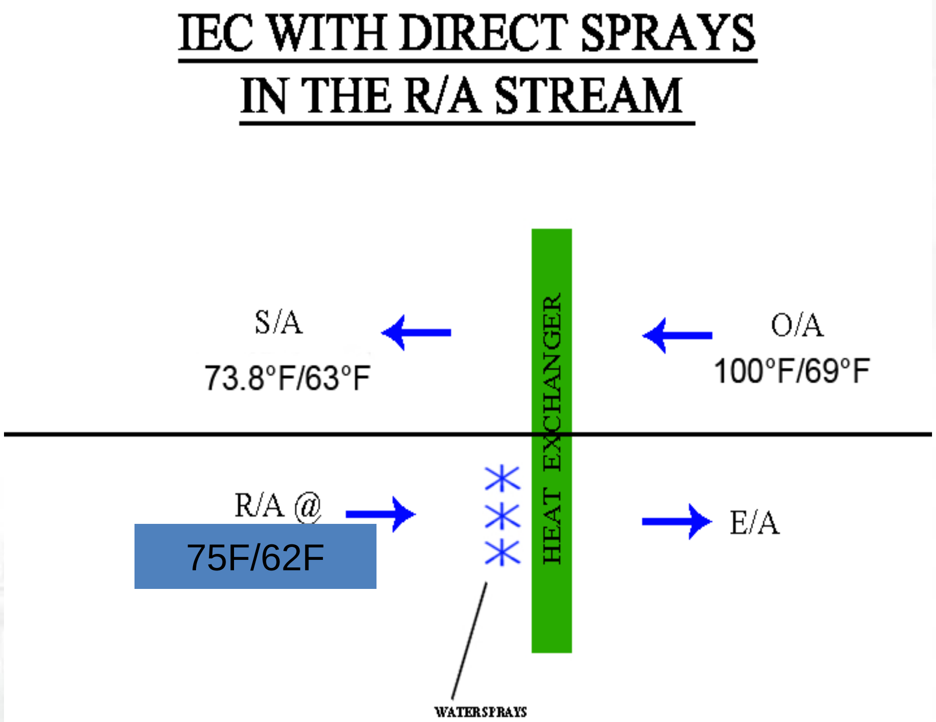
Wet Bulb Depression Efficiency(WBDE)

Effectiveness = 100% x $\frac{(EDBT-LDBT)}{(EDBT-WBT)}$

EDBT = Entering dry bulb temperature of primary air

LDBT = Leaving dry bulb temperature of primary air

WBT = Entering wet bulb temperature of secondary air



- More cooling than dry air to air HX

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Sample EER Calculation

CFM	10000
IEC EAT	100
R/A WB	62.5
WBDE	0.7
HP LAT (deg F)	73.75
dt	26.25
IEC cooling (btu/hr) =	**283500**
Net Total Cooling Capacity (btu/hr)	**283500**
IEC Pump HP	1
IEC Pump KW	0.7457
Supply air pressure drop from IEC	0.55
Supply fan BHP contribution from IEC	1.33
Supply fan motor eff	0.9
Supply fan KW contribution	1.10
Exhaust air pressure drop from IEC (wet side)	0.45
Exhaust fan BHP contribution from IEC	1.09
Exhaust fan motor eff	0.9
Exhaust fan KW contribution from IEC	0.90
Total Electric input to achieve cooling effect (KW)	**2.75**
EER	**103.0**

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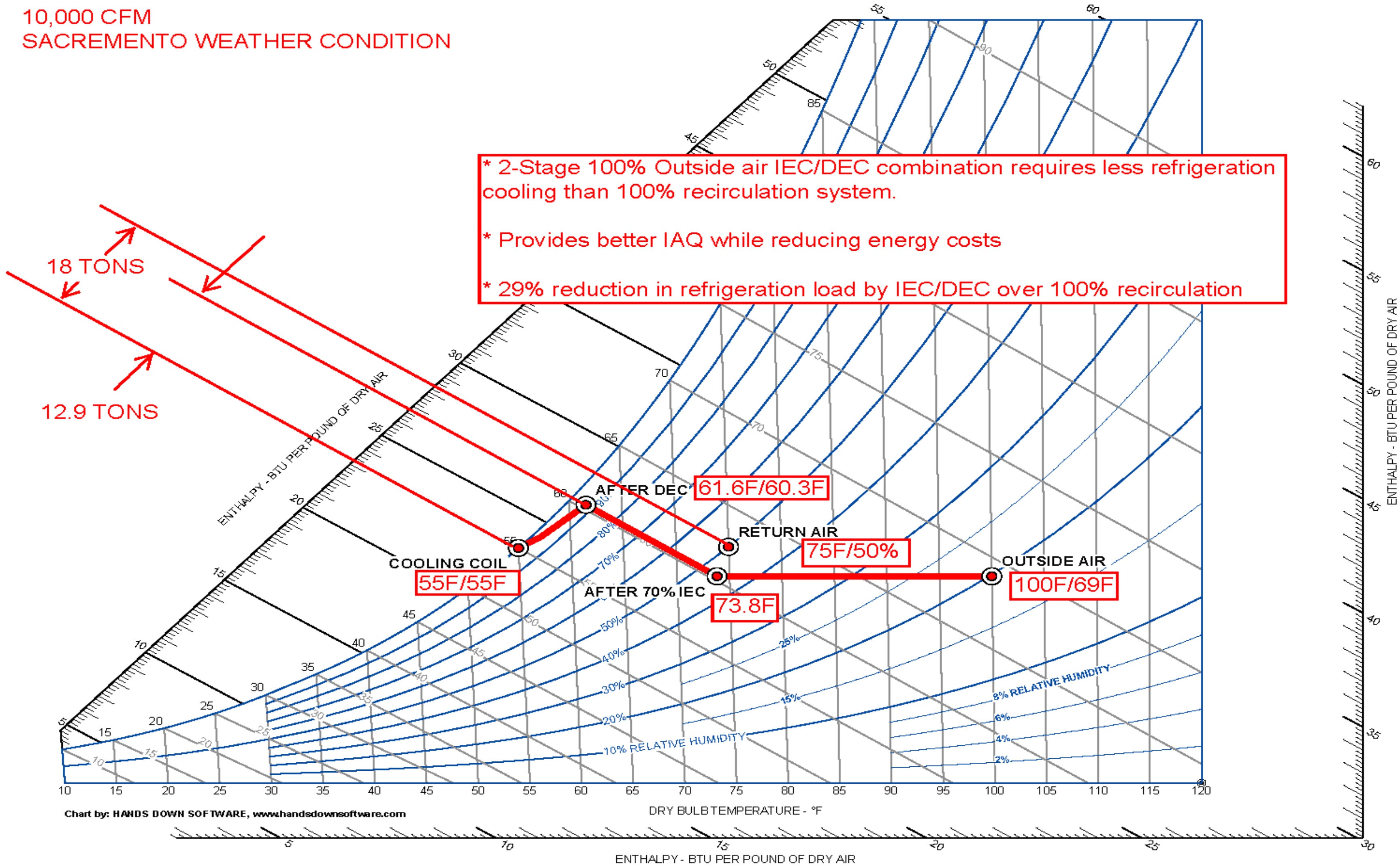
Combining IEC and DEC- IDEC Systems

100% O/A IEC/DEC VS 100% RECIRC SYSTEM
10,000 CFM
SACREMENTO WEATHER CONDITION

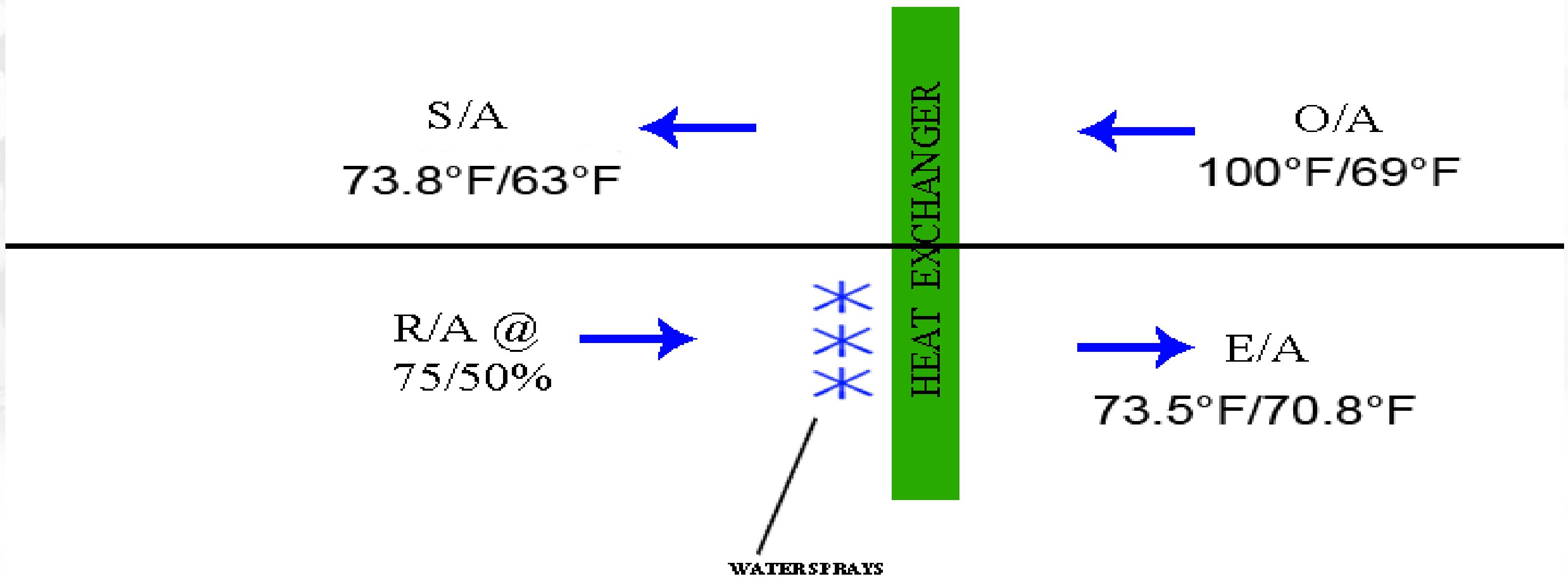


* 2-Stage 100% Outside air IEC/DEC combination requires less refrigeration cooling than 100% recirculation system.

* Provides better IAQ while reducing energy costs

* 29% reduction in refrigeration load by IEC/DEC over 100% recirculation

Triple Dip System



➢Humid but cool building exhaust air may be used for rejection of "Heat of Compression" for onboard DX refrigeration system.

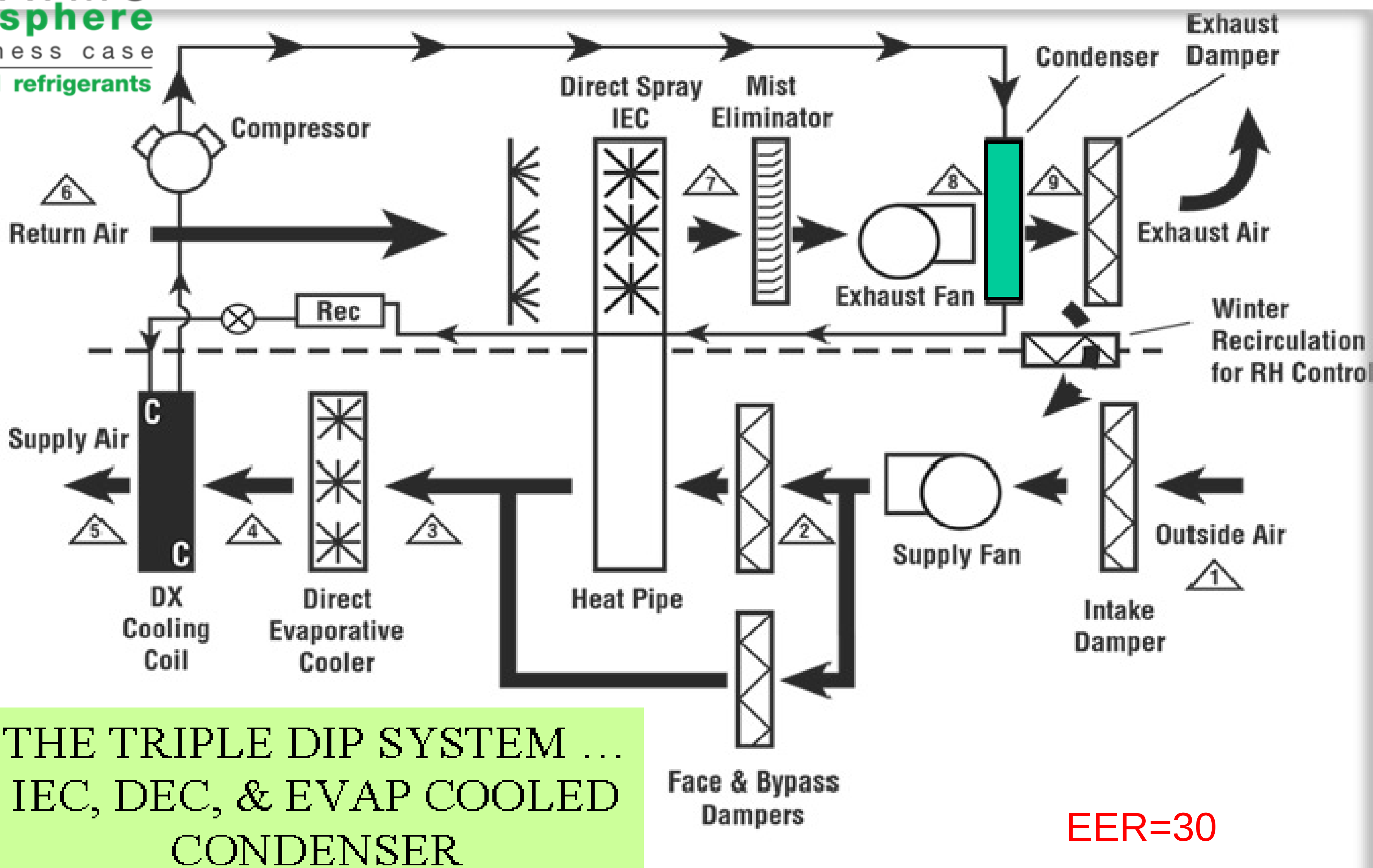


Figure 1

THE TRIPLE DIP SYSTEM …
IEC, DEC, & EVAP COOLED CONDENSER

EER=30

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ANNUAL ENERGY CONSUMPTION ANALYSIS

100% OUTDOOR AIR IDEC VAV SYSTEM

VS.

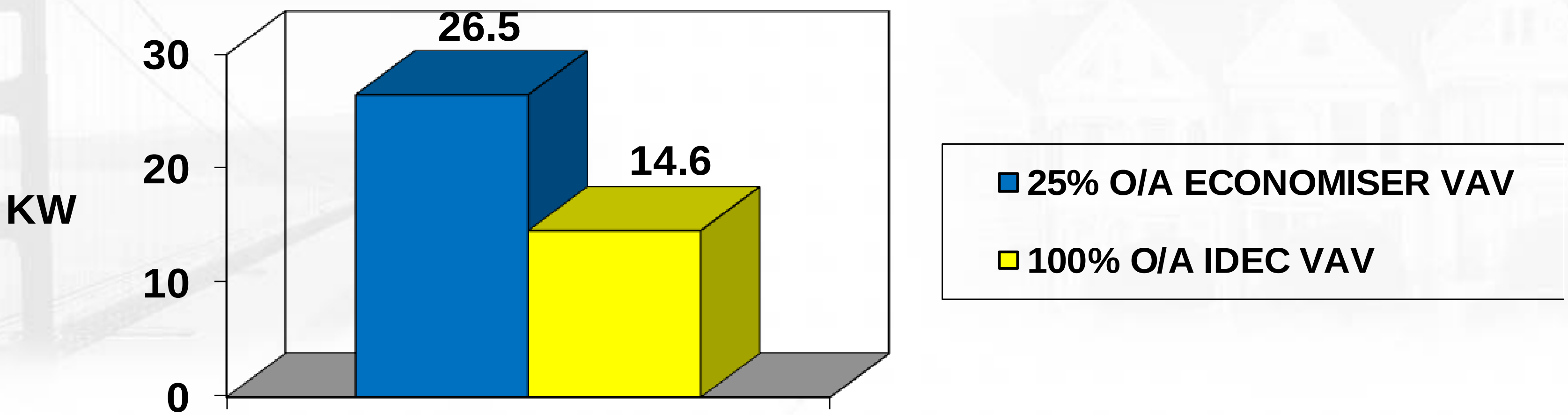
25% OUTDOOR AIR ECONOMISER VAV SYSTEM

PARAMETERS USED

- 10,000 CFM supply.
- Sacramento TMY3 data
- Supply air condition @ 55°F .
- Summer room temperature is 75°F and 50% RH.
- 7am-8pm/365days duty cycle.
- Winter room temperature is 70°F.
- IEC WBDE is 70%.
- DEC WBDE is 90%.
- 0.8 kW/ton chiller including auxiliary energy
- Winter heat recovery effectiveness is 50%.
- VAV minimum turndown is 25% at ambient conditions 55F and below.

Peak kW at Dry bulb Design Condition of 100F/70F

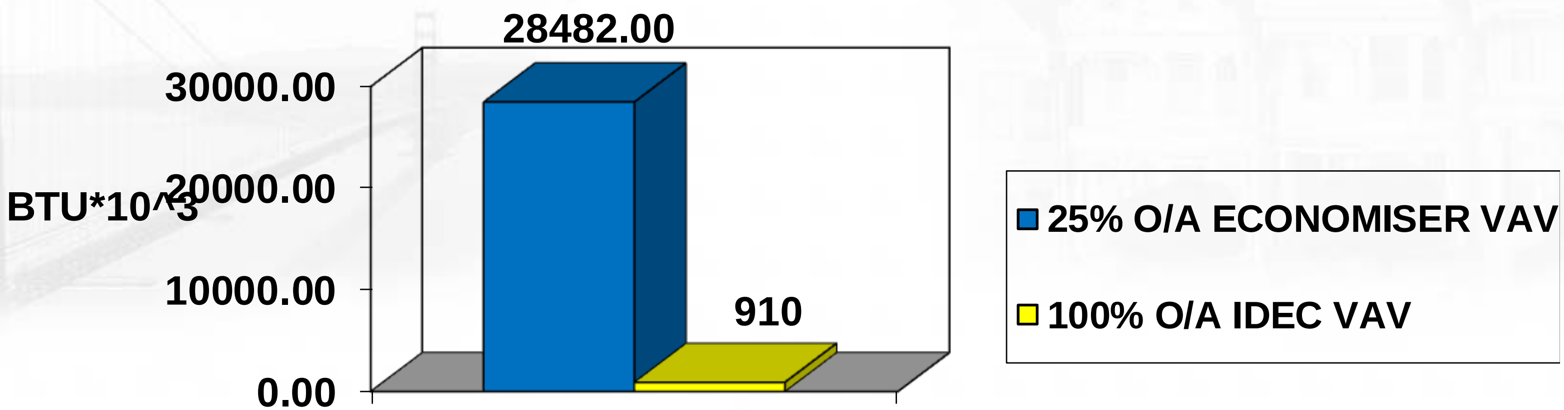
For 10,000 cfm VAV



- Significant reduction in peak demand charges for the IDEC design.
- Further peak KW reductions possible by combining IDEC system with TES.

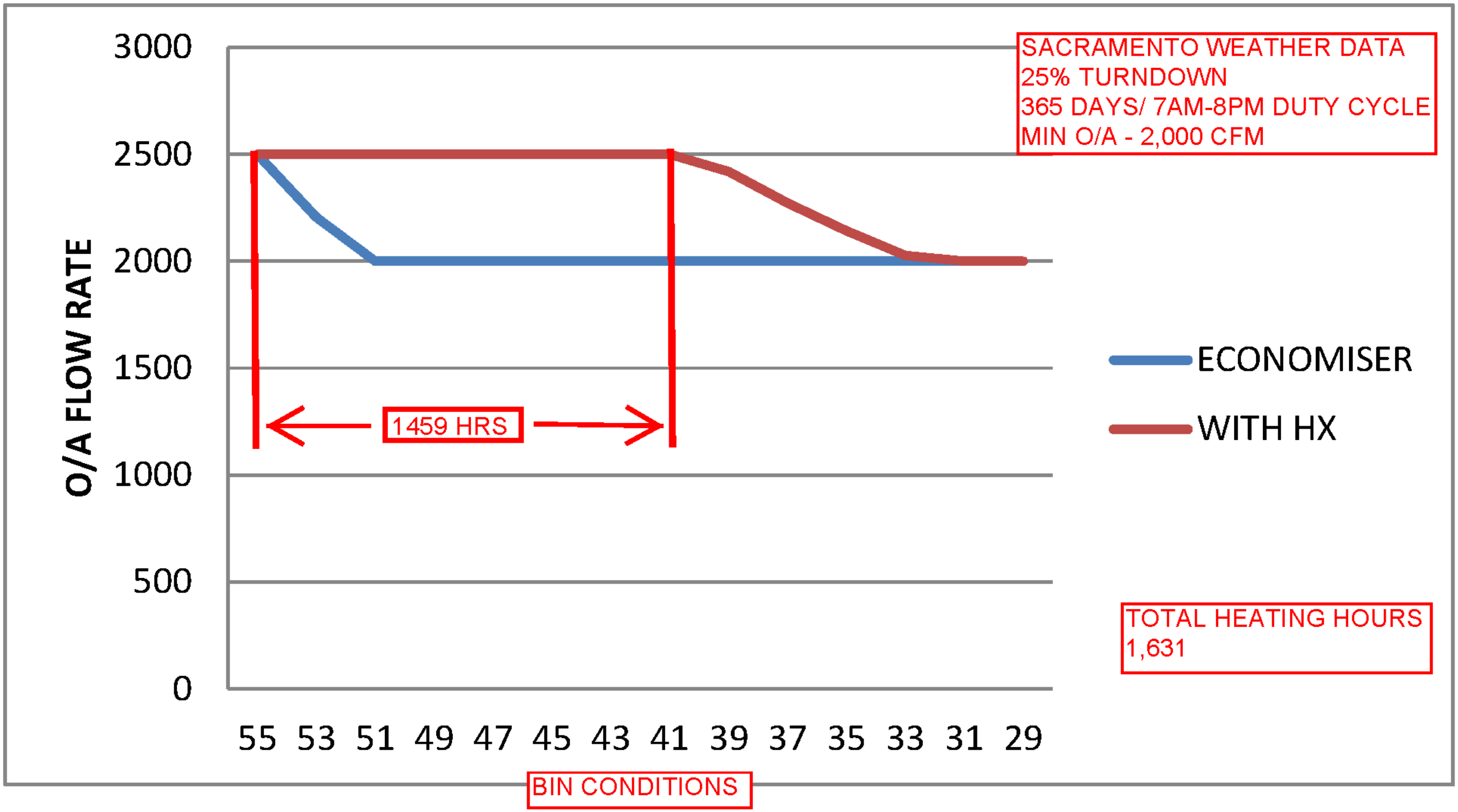
Annual Heating Requirement per 10,000 cfm

Sacramento, CA@ 7am-8pm/365 Duty cycle

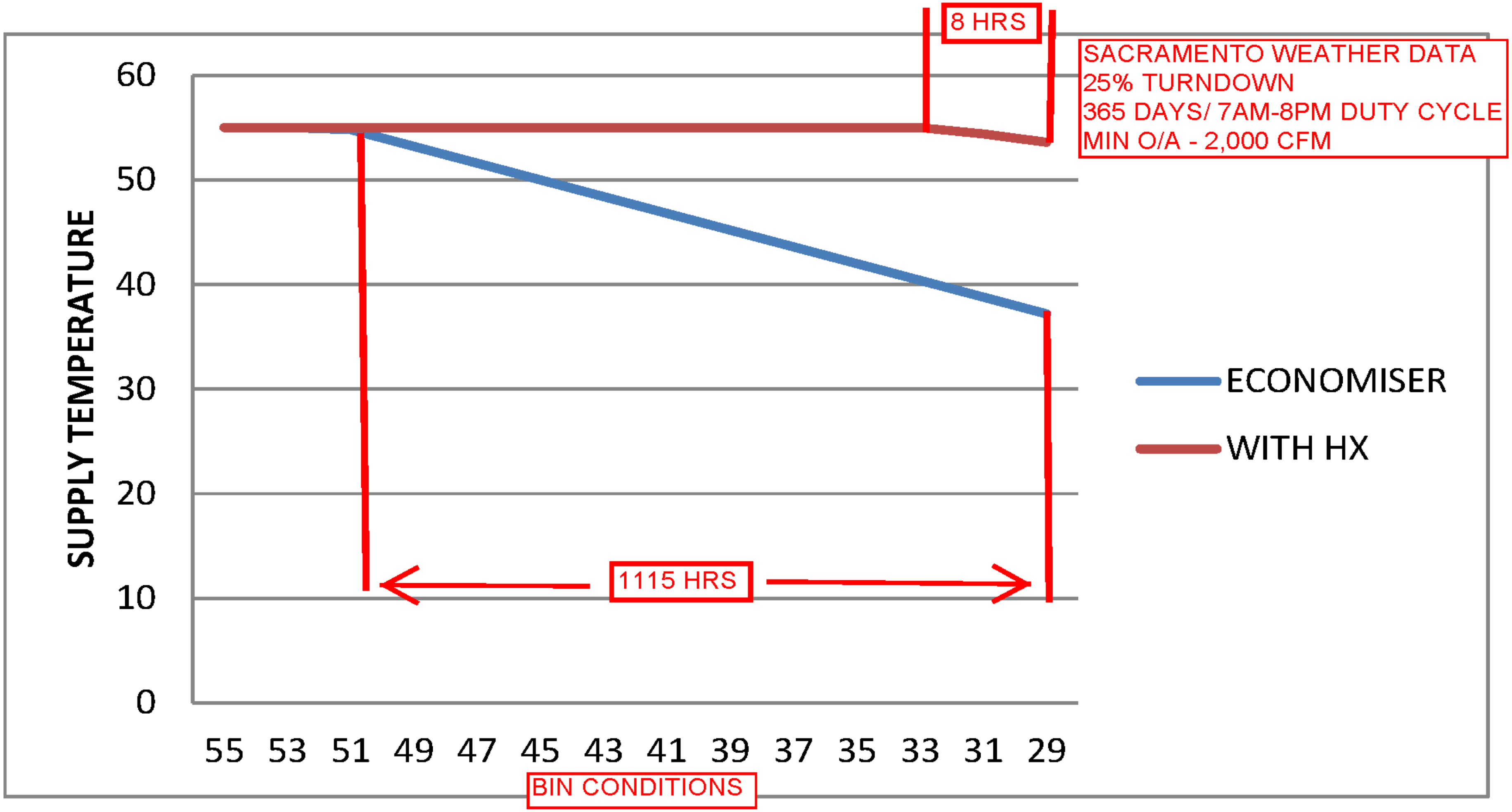


- VAV turndown considered for both systems.
- Significant reduction in heating requirements.

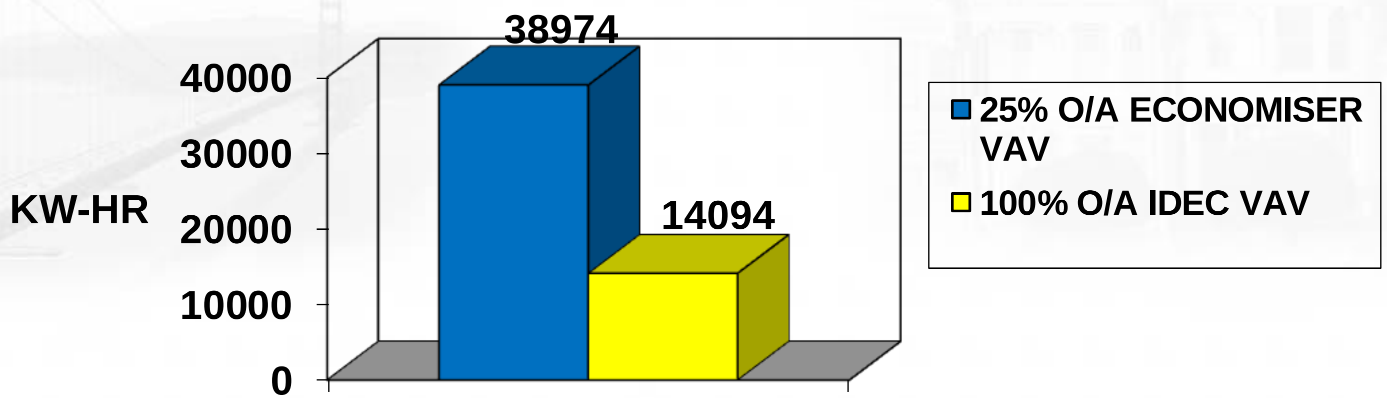
O/A FLOWRATE IN HEATING MODE



AUXILLARY HEATING REQUIREMENT



Annual KW-HR consumption per 10,000 cfm Sacramento, CA@ 7am-8pm/365 Duty cycle



- IDEC system KW HR consumption includes added fan KW to overcome pressure drops across Indirect/Direct components.

WATER CONSUMPTION

IEC VS CHILLER WITH COOLING TOWER

- Evaporation of 1 pound of water requires 1,000 BTU of heat
- To provide one ton of cooling, we need to remove 12,000btu/hr
- 1 ton of cooling requires 12lbs/hr of water consumption

Indirect Evaporative Cooler

Water Evaporation = 12 Lbs/hr =1.44 gallons/hr per ton of cooling

Cooling Tower

Chiller adds about 3,000 btu/hr of parasitic load for every 12,000 btu/hr of cooling (approx 25%)

Water Evaporation = 15 Lbs/hr =1.8 gallons/hr per ton of cooling

- Additional water is wasted in CT due to drift.
- Bleed rate is higher due to higher evaporation rate and low cycles of concentration

Water consumed at the power plant

- 2 gallons of water is required for every kWh of electrical power consumed

Chiller

- Efficiency of chiller is 0.8kW/ton
- 1 ton of cooling provided by chiller requires **1.6 gallons/hr** at the power plant

IEC

- Efficiency of IEC is 0.2kW/ton
- 1 ton of cooling provided by IEC requires **0.4 gallons/hr** at the power plant

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