# Sigler Commercial

# INNOVATION IS IN THE AIR

Representing Industry Leading Manufacturers of Commercial HVAC Products & Solutions

Carrier — Turn to the experts

## Water Cooled Chillers

**AquaForce® 30HX/XW Screw**
- 75 to 400 Tons
- HFC-134a - HCAI/OSHPD
- Small Footprint
- Heat Recovery

**AquaEdge® 23XRV**
- 175 to 550 Tons
- R-134a, R-513a
- High Efficiency Variable Speed Screw Compressor
- HCAI/OSHPD
- IPLV to .299 KW/ton

**AquaEdge® 19XRV**
- 200 to 3,400 Tons
- R-134a, R-513a
- Variable-Speed Centrifugal
- IPLV to .31 kW/Ton
- HCAI/OSHPD

**AquaEdge® 19DV**
- 200 to 1000 Tons
- Oil Free Ceramic Bearings
- R-1233zd(E) Refrigerant
- 2-Stage Compressor with VFD
- Free Cooling & Heat Recovery
- Low GWP Refrigerant
- IPLV to .29 kw/ton

**AquaEdge® 19MV**
- 300 to 700 Tons
- Oil Free Magnetic Bearings
- R-134a , R-513a Refrigerant
- 2-Stage Compressor with VFD
- Compact Design
- Low GWP Refrigerant
- IPLV to .29 kw/ton

## Air Cooled / Modular Chillers

**AquaForce® 30XV**
- 140 to 500 Tons, Nominal
- Variable Speed Compressor and condenser fans
- Greenspeed® Intelligence
- R-134a and R-513a
- Flexible Footprint
- IPLV to 21 EER
- HCAI/OSHPD

**AquaSnap® 30MP Scroll**
- 15 to 71 Tons HCAI/OSHPD
- Connect Modules to 600 Tons
- Heat Recovery Option
- Water or Remote Air-cooled

**AquaSnap® 30RAP Scroll**
- 10 to 150 Tons HCAI/OSHPD
- Digital Scroll Compressor
- Up to 16.8 EER
- Variable Speed Condenser Fans
- Factory Hydronic Pump Package Option

**AquaSnap® 30RB Scroll**
- 60 to 300 Tons
- Heat Recovery Desuperheater
- Up to 17.1 IEER
- Variable Speed Condenser Fans
- Factory Hydronic Pump Package Option
- HCAI/OSHPD

## Packaged Rooftop Units

**WeatherExpert™ 48LC/50LC**
- 6 to 23 Tons
- Up to 21 IEER
- Multi-Zone VAV

**WeatherMaster™/Maker™ 48/50TC(Q)/HC(Q)**
- 6 to 25 tons
- Up to 20 Tons Heat Pump

**WeatherMaster™/Maker™/Expert™ 48/50 A, P Series**
- 20 to 100 Tons
- VAV, CV, SAV
- Evaporative Condenser Options

**WeatherMaster™/Maker™w/EcoBlue™ 48/50FC(Q), GC(Q), JC**
- 3 to 25 Tons (Heat Pump)
- Vane Axial ECM Motor
- Up to 16 SEER HCAI/OSHPD
- ULN Ultra Low Nox

## Classroom Indoor Package Unit

AIRSYS — Balance the Environment

- 2 to 5 Tons Heat Pump
- Wall mounted
- Ultra low sound Level
- Inverter Compressors

## Air-Cooled Condensing Units

**Gemini® Condensing Units**
- 6 to 130 Tons HCAI/OSHPD
- Small Footprint
- Single & Dual Circuit
- Digital Compressor

## Variable Refrigerant Flow

**3-Pipe Heat Recovery/Heat Pump**
- 3 to 38 Tons
- Inverter Twin Rotary Compressor
- Turndown to 3,500 BTUH
- Flow Selector Powered via FCU
- Single Phase HR to 12 Tons
- Rooftop FCU 3-5 ton

**2-Pipe Heat Recovery/Heat Pump**
- 3 to 36 Tons HCAI/OSHPD
- Inverter Twin Scroll Compressor
- Single Point Piping & Wiring on all Condensing Unit Sizes

Patterson — The Pump People — A Gorman-Rupp Company
- Pumps
- Heat Exchangers
- Booster Systems

*NA in San Diego

Kelvion
- Plate and Frame Heat Exchangers
- Adiabatic Hybrid Coolers

Hunter

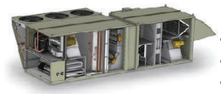
**HVLS Fans**
Direct Drive
Lightweight
BACnet

PHP SYSTEMS/DESIGN — BUILD IT RIGHT.

Roof pipe/duct supports
Service walkways, ramps, crossovers
Zero penetration support

DELTA Cooling Towers, Inc.
- Cooling Towers
- HDPE
- Anti Microbial
- Reduced Weight
- Made in USA

## 100% Outside Air & Energy Recovery



**100% OA Units**
- 3 to 60 Tons
- SAT or RH/T Control
- Heat Pump / Gas Heat
- Packaged and Split

RenewAire

**Energy Recovery Ventilators**
- Indoor & Outdoor Installation
- 40 to 13,200 CFM
- Demand Controlled Ventilation
- ECM Fan Motors

## Water-Source Heat Pumps & Indoor Self-Contained

**AquaZone® WSHP**
- .5 to 30 Tons
- Vertical/Horizontal
- EER up to 37
- ECM Motors

**OmniZone® SCU**
- 5 to 60 Tons
- CAV/VAV
- Air Cooled, Remote Air Cooled, Water Cooled

## Fan Coil Units & Coils

**AirStream® 42**
- 200 to 4,000 CFM
- ECM Motors
- 2 & 4 Pipe, DX
- Stack, Cassettes

**Coils**
- CHW/HW, DX
- Distributed Steam
- Copper, Stainless Steel, Aluminum

## Packaged Central Plants & Controls

**Modular & Custom CHW/HW Plants**
- Space Saving
- Integrated Controls
- Single Point Responsibility
- Reduce Project Costs

**Building Automation/i-Vu**
- Factory Engineered & Optimized Programs
- Seamless Integration
- Open Protocol
- Single Point Responsibility

## Air Handling Units

Carrier

**Fully Custom**
- 200 to 300,000+CFM
- Fan Array
- Indirect/Direct Evapor. Cooling
- Energy Recovery
- Made in the USA
- HCAI/OSHPD

**Modular and Semi-Custom**
- 400 to 60,500 CFM
- Direct Expansion, CHW Cooling
- Hot Water, Gas Heat
- Energy Recovery + Multi-Zone



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## Mixed-Air Equations

| | |
|---|---|
| Mixed-air temperature | $T_{MA} = \frac{(T_{OA} \times CFM_{OA}) + T_{RA} \times CFM_{RA}}{CFM_{MA}}$ |
| Mixed-air enthalpy | $h_{MA} = \frac{(h_{OA} \times CFM_{OA}) + h_{RA} \times CFM_{RA}}{CFM_{MA}}$ where h = enthalpy, Btu/lb of dry air |

*Adapted from 2017 ASHRAE Handbook - Fundamentals, Ch. 16, Eq. 2.*

## Psychrometric Equations

| | |
|---|---|
| Sensible load (Btu/h) | $q_s = 1.10 \times CFM \times (T_2 - T_1)$ |
| Latent load (Btu/h) | $q_L = 4840 \times CFM \times (W_2 - W_1)$ where W = humidity ratio<br>$q_L = 0.68 \times CFM \times$ Delta grains<br>7000 grains = 1 $lb_{H2O}$ |
| Total load (Btu/h) | $q_T = 4.5 \times CFM \times (h_2 - h_1)$ where h = enthalpy, Btu/lb of dry air |
| Humidification (lb/h) | $lb/h = \frac{(CFM \times 60 \times (W_2 - W_1))}{\text{specific volume of air}}$ where W = humidity ratio |
| Hydronic load (Btu/h) | $q_{water} = 500 \times GPM \times (T_2 - T_1)$ |

*Adapted from 2017 ASHRAE Handbook - Fundamentals, Ch. 17, Eq. 1-3; Don Brandt, Fundamentals of Psychrometrics, 2nd ed. (I-P), A Course Book for Self Directed or Group Learning (Atlanta: ASHRAE, 2016); 2020 ASHRAE Handbook - HVAC Systems and Equipment, Ch. 13, Eq 9; HVAC Design Essentials ALI course, Level 1, Section 6 and 7.*

## Envelope Equations

$Q = U \times A \times (T_2 - T_1)$

where

Q = heat transfer, Btu/h

U = thermal transmittance, Btu/h·ft²·°F

A = area, ft²

$T_2$ = temperature outside, °F

$T_1$ = temperature inside, °F

| | |
|---|---|
| SC to SHGC | SHGC = SC x 0.864 |
| U-factor to R-value | 1/R = U-factor |
| Adding R-values | $R_{total} = R_1 + R_2 + R_3 + R_4$ where R = resistance to heat flow, ft²·°F·h/Btu |

*Adapted from 2017 ASHRAE Handbook - Fundamentals, Ch. 15, Eq. 1 and Ch. 25, Eqs. 7 amd 11.*

## Fan Affinity Laws

$$CFM_2 = CFM_1 \times \left(\frac{RPM_2}{RPM_1}\right)$$

$$SP_2 = SP_1 \times \left(\frac{RPM_2}{RPM_1}\right)^2$$

$$HP_2 = HP_1 \times \left(\frac{RPM_2}{RPM_1}\right)^3$$

*Adapted from 2020 ASHRAE Handbook - HVAC Systems and Equipment, Ch. 21, Table 2, Eq. 1.*

## Equipment Efficiencies

| | |
|---|---|
| Fan efficiency<br>Note: TSP units are in w.g. | Fan efficiency = $\frac{CFM \times TSP}{\text{fan BPH} \times 6356}$ |
| Pump efficiency<br>Note: Pump head units are ft w.g. | Pump efficiency = $\frac{GPM \times \text{pump head} \times \text{specific gravity [1.0]}}{3960 \times \text{pump BHP}}$ |
| COP | = (EER)/3.412 = 12/(kW/ton)/3.412<br>= Chiller capacity/compressor power input<br>= $Q_{chiller} / W_{net,in}$<br>where<br>$Q_{chiller}$ = chiller load<br>$W_{net,in}$ = work in |
| EER | = 12/(kW/ton) = COP x 3.412 |
| kW/ton | = 12/EER = 12/(COP x 3.412) |

*Adapted from AMCA 205-19 per 2020 ASHRAE Handbook - HVAC Systems and Equipment, Ch. 21; 2020 ASHRAE Handbook - HVAC Systems and Equipment, Ch. 44, Eq. 5 and Ch. 48; AHRI Standard 550/590 (I-P), 2020 Standard for performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle (Arlington, VA: Air-Conditioning, Heating, and Refrigeration Institute, 2020); 2017 ASHRAE Handbook - Fundamentals, Ch. 2, Eqs. 14-16*

## Cooling Tower Equations

Evaporation GPM = flow GPM x range (°F) x 0.001

Bleed rate GPM = $\frac{\text{evaporation GPM}}{\text{cycles of concentration - 1}}$

*Adapted from 2020 ASHRAE Handbook - HVAC Systems and Equipment, Ch. 40; 2019 ASHRAE Handbook - HVAC Applications, Ch. 50, Section 2.1, Retention Time.*

## Pump Affinity Laws

$$\frac{GPM_1}{GPM_2} = \frac{RPM_1}{RPM_2} \rightarrow GPM_2 = GPM_1\left(\frac{RPM_2}{RPM_1}\right)$$

$$\frac{TDH_1}{TDH_2} = \left(\frac{RPM_1}{RPM_2}\right)^2 \rightarrow TDH_2 = TDH_1\left(\frac{RPM_2}{RPM_1}\right)^2$$

$$\frac{BHP_1}{BHP_2} = \left(\frac{RPM_1}{RPM_2}\right)^3 \rightarrow BHP_2 = BHP_1\left(\frac{RPM_2}{RPM_1}\right)^3$$

*Adapted from 2020 ASHRAE Handbook - HVAC Systems and Equipment, Ch. 44, Table 1.*

## Air Changes per Hour

ACH = (CFM x 60)/(area x height)

Convert to CFM from ACH: CFM = (area x height) x ACH/60

## Common Conversions

| | |
|---|---|
| watts to Btu/h | Btu/h = 3.412 x watts |
| HP to Btu/h | Btu/h = 2545 x HP |
| HP to watts | watts = 746 x HP |
| PSI | PSI = 2.31 x ft head |
| tons to Btu/h | 1ton = 12,000 Btu/h |
| MBH to Btu/h | 1 MBH = 1,000 Btu/h |
| BHP to kW | 1 BHP = 0.746 |
| Atm to PSI | 1 Atm = 14.7 psi |
| $ft^3$ to gal | 1 $ft^3$ = 7.5 gal |
| Steam condensate lb/h - gpm | 1000 lb/h condensate = 2 gpm |

*Adapted from 2017 ASHRAE Handbook - Fundamentals, Ch. 39.*