

Valent – DOAS Solutions

Efficiency, Refrigeration & Codes



Introductions



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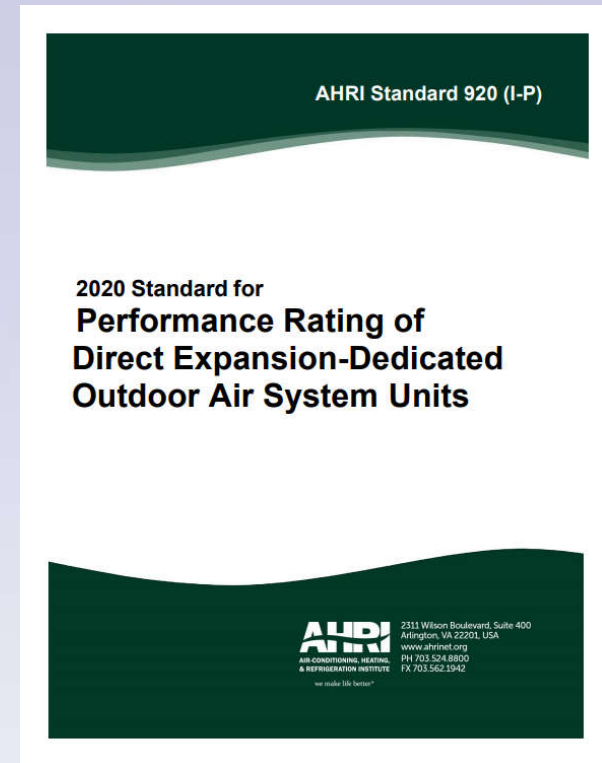
Brian Jennissen
Area Sales Manager
Innovent & Valent

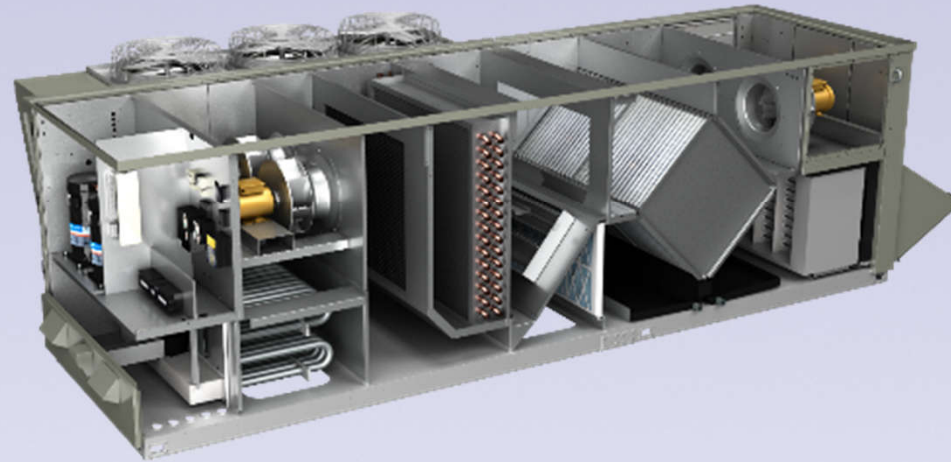
Presentation Outline

- DOAS Definition & Challenges
- Valent Product Overview
- DOAS Design Considerations
 - Capacity Control
 - Dehumidification
 - Efficiency
- DX Cooling – Efficiency Codes in Ontario

DOAS Definition - AHRI

“A type of air-cooled, water-cooled, or water source factory assembled product which dehumidifies 100% outdoor air to a low dew point, **and includes reheat that is capable of controlling the supply dry-bulb temperature...**”





Challenges and Considerations

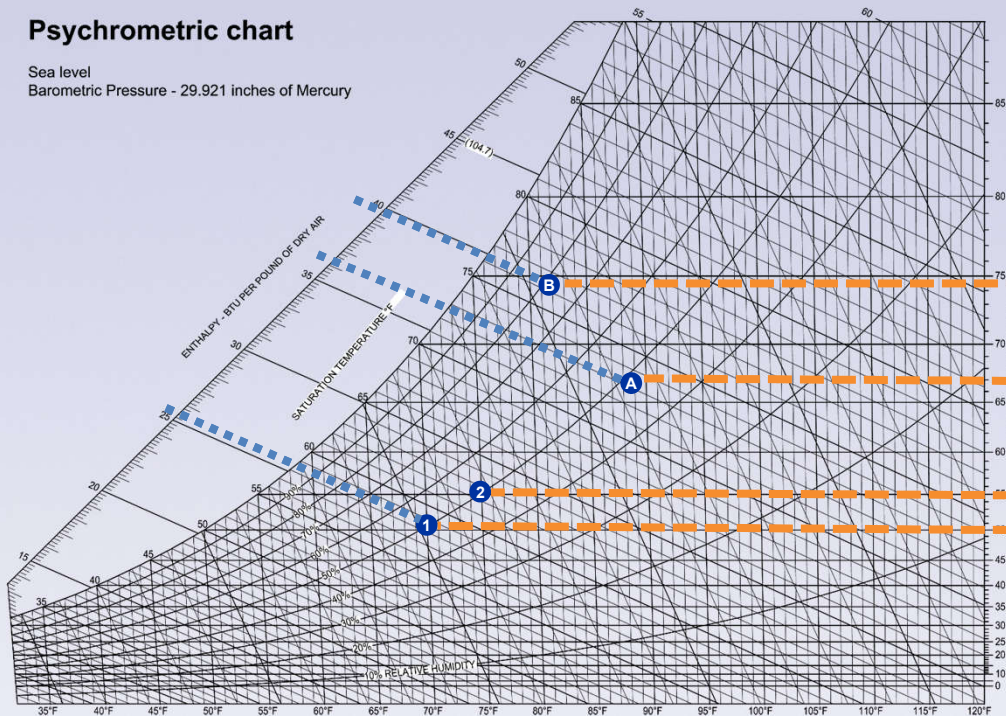
DESIGNING DEDICATED OUTDOOR AIR SYSTEMS

DOAS Design

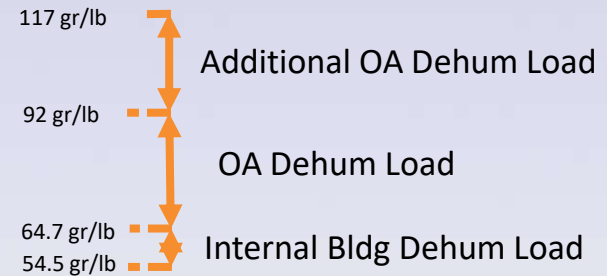
- A** Cooling Design Day → 88/72 DB/WB
- B** Dehumidification Design Day → 80/74 DB/WB
- 1** DOAS DAT → (50 Deg dp DX Coil)
- 2** Return Temp → 75.0 / 50% DB/RH

Psychrometric chart

Sea level
Barometric Pressure - 29.921 inches of Mercury



Which design day should you use?



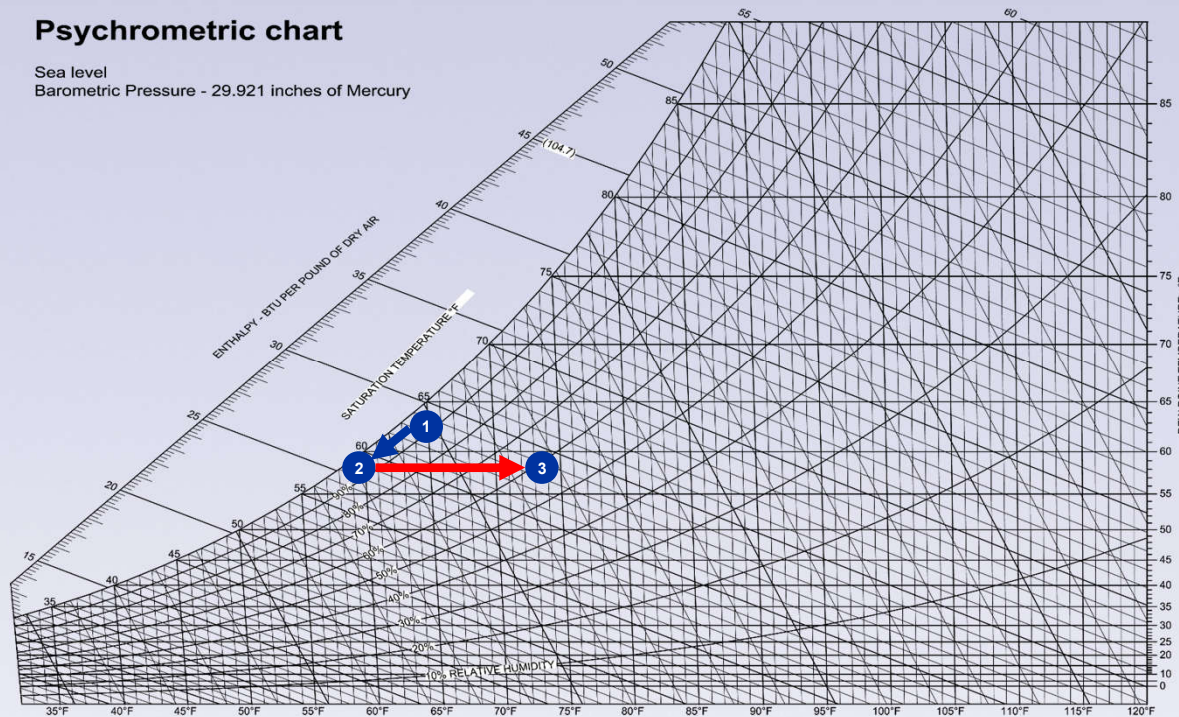
Toronto design conditions (ASHRAE 0.4%)

DOAS Operation – Off Peak



Psychrometric chart

Sea level
Barometric Pressure - 29.921 inches of Mercury



Outside Air Conditions

- 1 - 65 / 90% DB / RH%
- Summer Morning

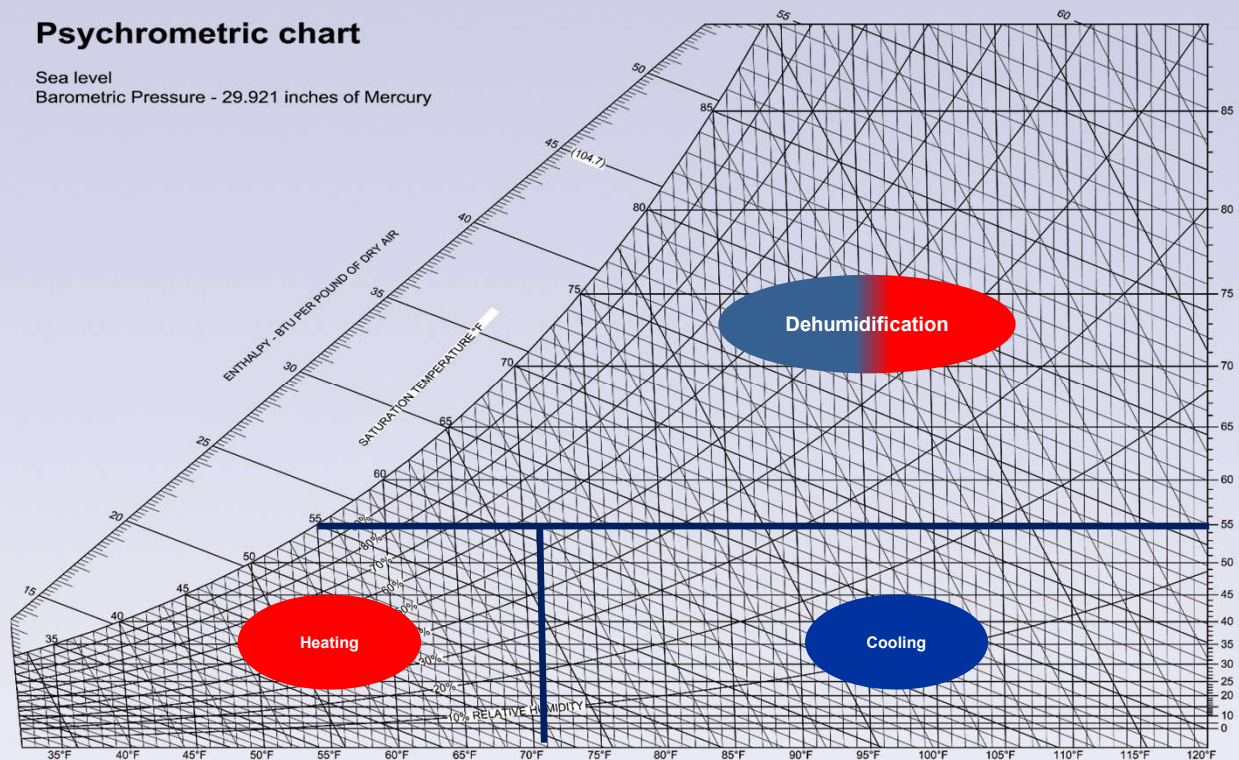
Dehumidification Mode

- 2 - DX Coil Set Point: 58 Degrees
 - Likely need modulating cooling source to avoid overcooling
- 3 - Reheat Set Point: 72 Degrees
 - Do you have enough HGRH available?
 - If critical, want another heating source

DOAS – Mode Selection

Psychrometric chart

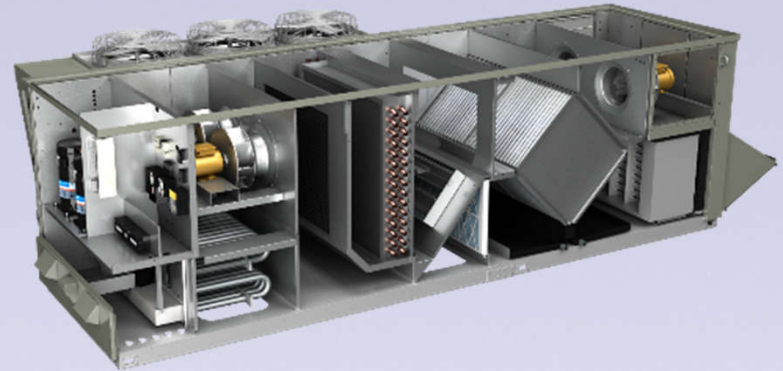
Sea level
Barometric Pressure - 29.921 inches of Mercury



- Typical Modes:
 - Cooling (> 72 degrees)
 - Heating (< 72 degrees)
 - Dehum (> 55 dew point)
- Determine Mode Based on:
 - Outside Conditions
 - Return Air / Space Conditions
 - Combination of above
- Application Considerations:
 - Air Changes
 - Internal Loads

How are DOAS Units Different?

- Separate modes of operation
- Coils with large surface areas and sufficient depth
- Large heating capacities
- Robust control sequences
- Modulating Components
- High R-value, thermally broken casing
- Integral energy recovery

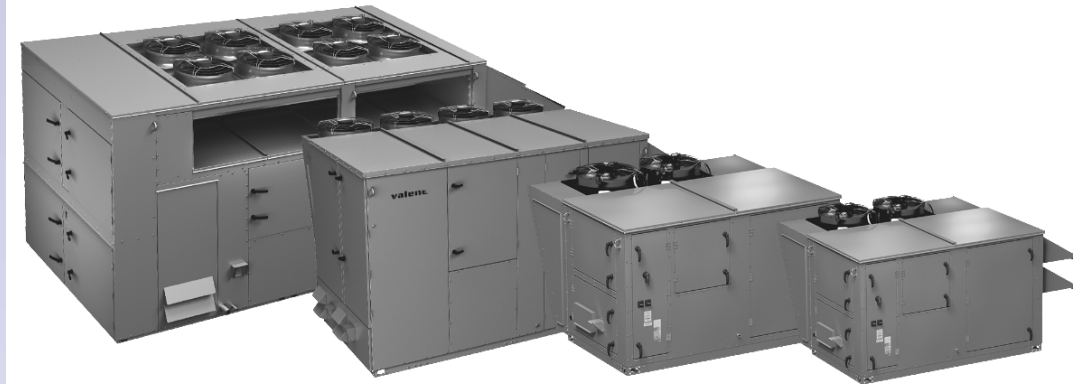


DOAS Design Take-Aways

- Important to consider dehumidification design conditions
- Spaces require appropriate temperature and humidity levels
- The range of incoming air conditions a DOAS unit sees is extreme
- DOAS = Separate cooling and dehumidification modes

Valent - Product Overview

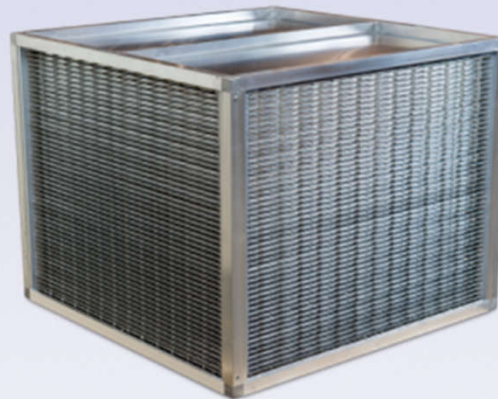
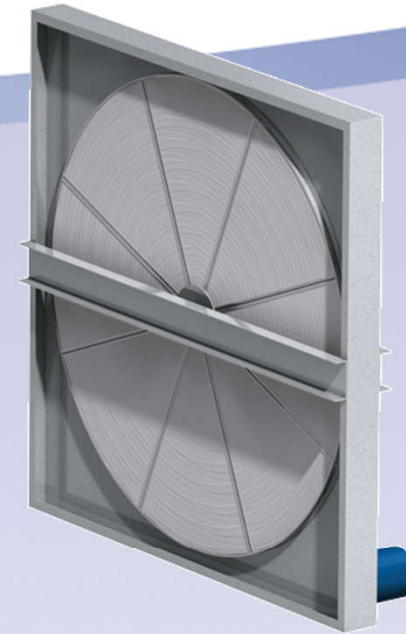
- **Airflow Range**
 - 500 – 18,000 CFM
- **Cooling Range**
 - 4-70 tons (down to 50F)
 - Packaged or Split DX
 - WSHP and ASHP
 - CW
- **Heating Range**
 - 100 – 1200 MBH (Up to 100F rise)
 - Gas
 - Electric
 - HW
 - Temperator (Hybrid Gas & Electric)
- **100% Outdoor Air and/or Recirc**
- **With or without energy recovery**



ERV Options

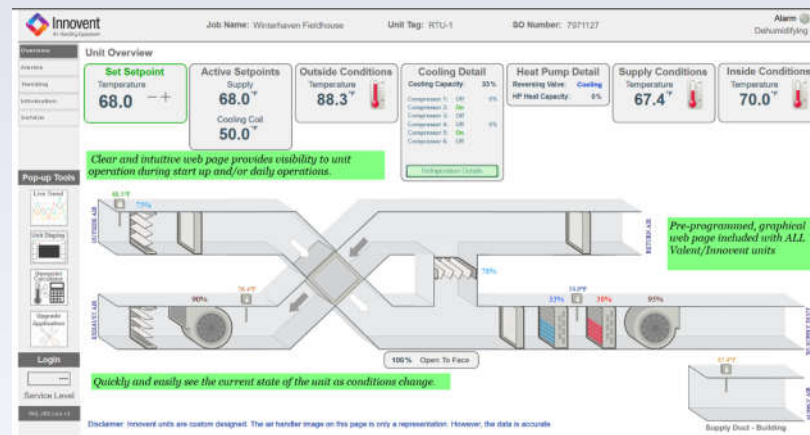
Three types

- Full-size polymer segmented wheel
 - Options: Bypass, Aluminum
- Sensible plate
 - Bypass
- Enthalpic Core
 - Bypass



Integrated Controls Platform

- Powerful microprocessor controls system (Carel)
- Standard features
 - Internal time-clock
 - Temperature control sequences
 - Web-based communication (Web-UI)
- Optional features
 - Communication (BACnet MSTP, BACnet IP, LonTalk)
 - Secondary sequences (VAV, pressurization, demand control)



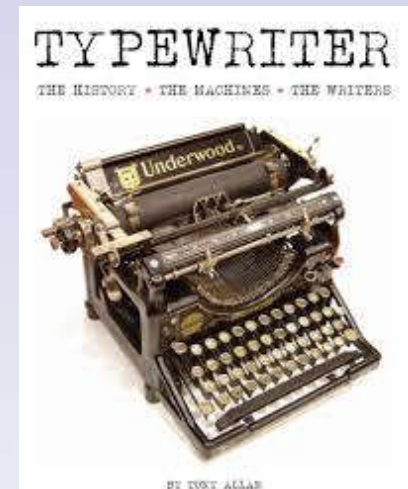
Lets talk about refrigeration

What they do ...

- Digital scroll (STANDARD)
- Inverter scroll
- Hot gas reheat
- Active head pressure control
 - AHP1.0 vs. AHP2.0

What they DON'T do ...

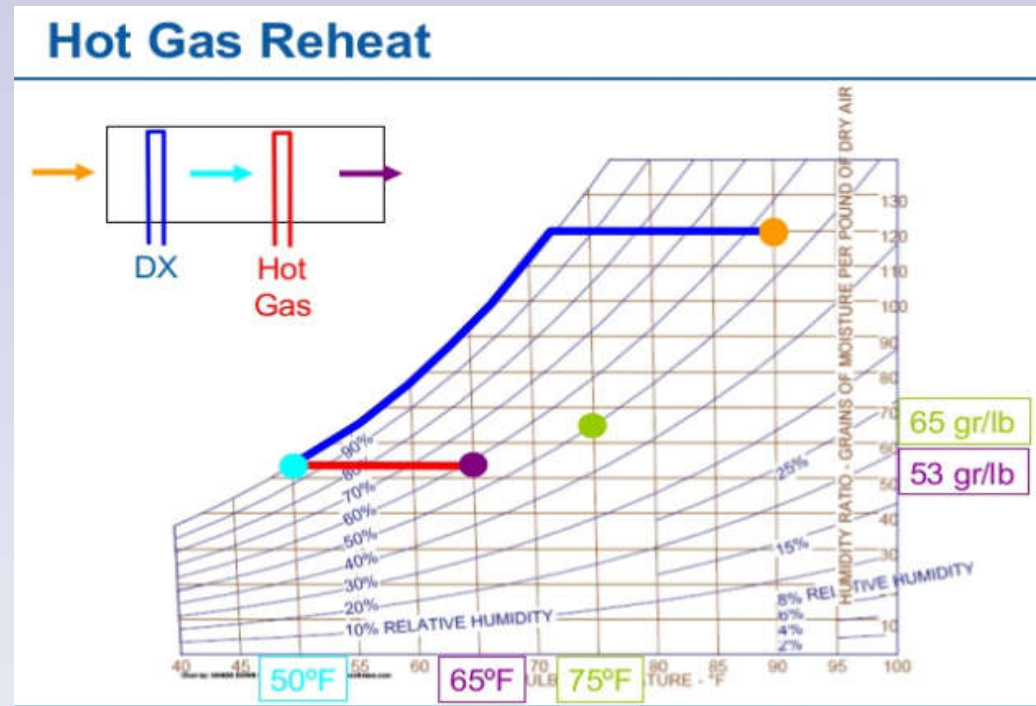
- Hot gas bypass
- Evaporator coil bypass



DEHUMIDIFICATION

Hot Gas Reheat

- Reheat dehumidified air to avoid overcooling the space
- Recycles energy from the compressor (no supplementary heat)
- Effective dew point control



Refrigeration Systems - AC

- Separated HGRH and evaporator coil
 - Allow for accurate measurement of evaporator leaving air temperatures
 - Support indoor air quality by providing complete access to coil for cleaning
 - Prevent evaporation of condensate

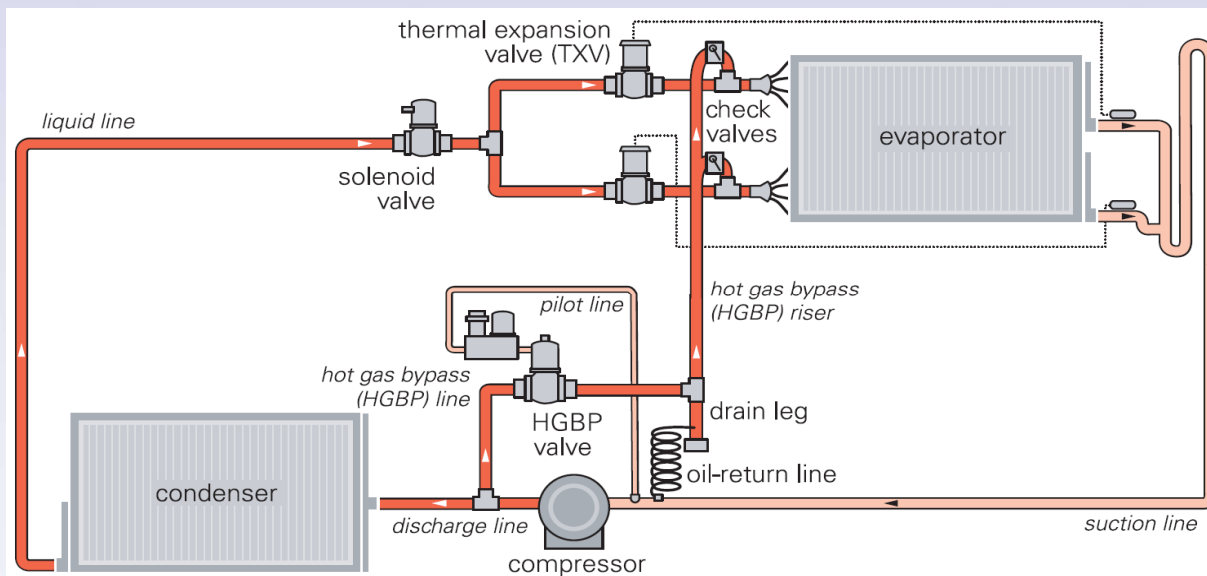


Managing part loads effectively

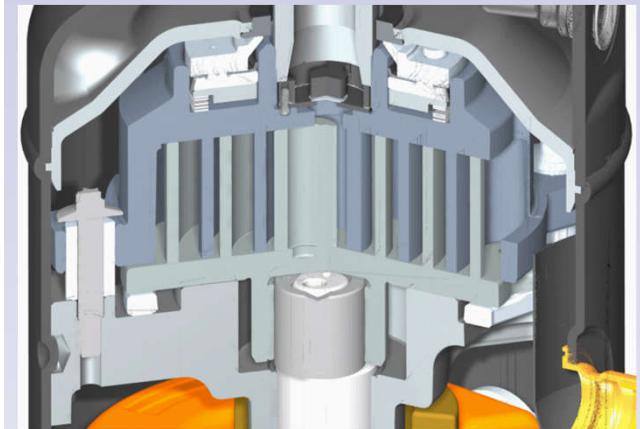
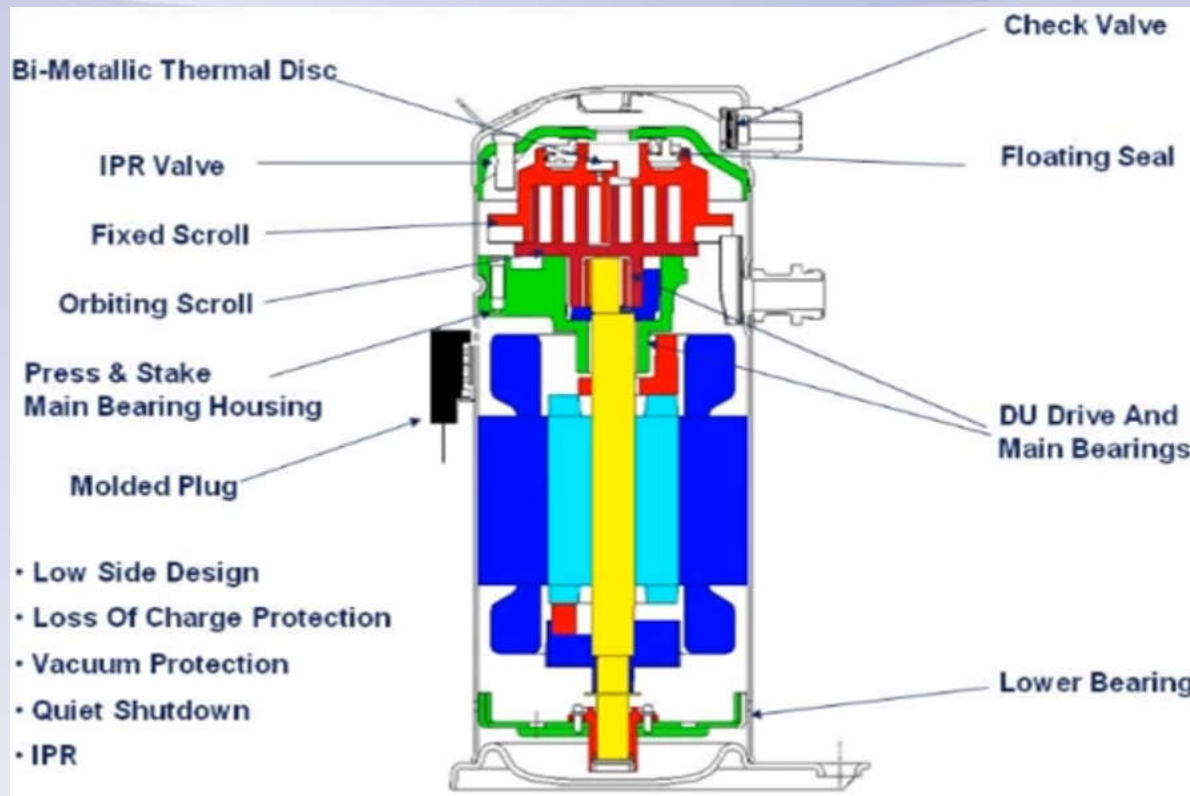
CAPACITY CONTROL

Hot Gas Bypass

- “Mature Technology” used prior to the widespread use of modulating compressors.
- Allows hot, gaseous refrigerant to bypass the condenser to falsely load the system at low load conditions.
- Greatly reduces operating efficiency because the bypassed vapor is not able to reject heat. This allows the refrigeration capacity to modulate, but not in an efficient way.



Scroll Compressor Basics



gas enters



open sealed off
as gas drawn into
spirals



gas compressed



discharge pressure
reached at center port

Digital vs. Inverter Scroll

Digital Scroll

- Continuous rotor speed
- Capacity control (10-100%)
- Modulation achieved by separating the scrolls by 1mm
- ~30% energy savings
- All voltages
- Loud

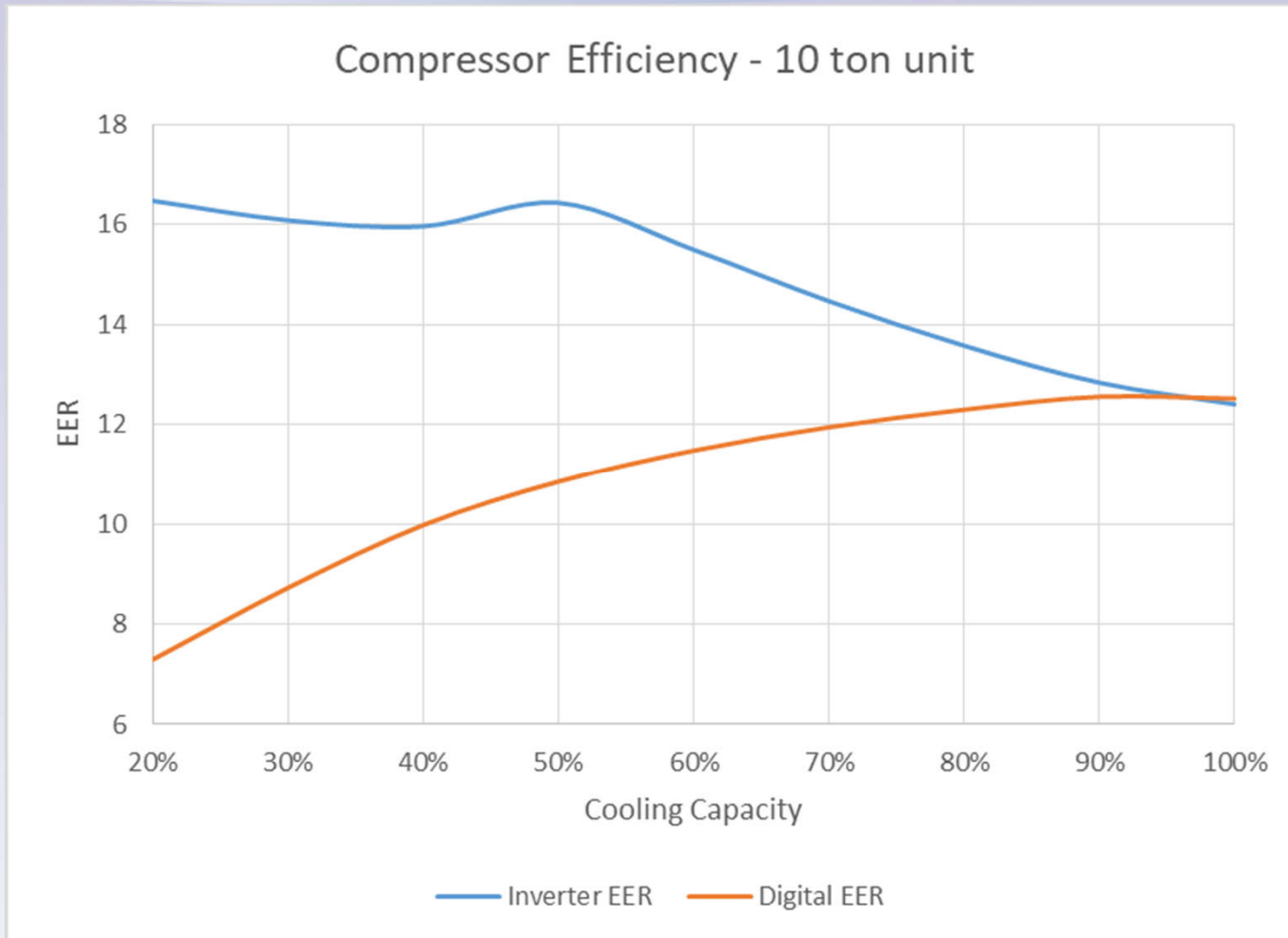


Inverter Scroll

- Variable rotor speed
- Capacity control (33-100%)
- Modulation achieved by adjusting the scrolling frequency
- >50% energy savings
- 208/3 or 460/3 only
- Quiet



Compressors



Beyond Compressors

EFFICIENCY

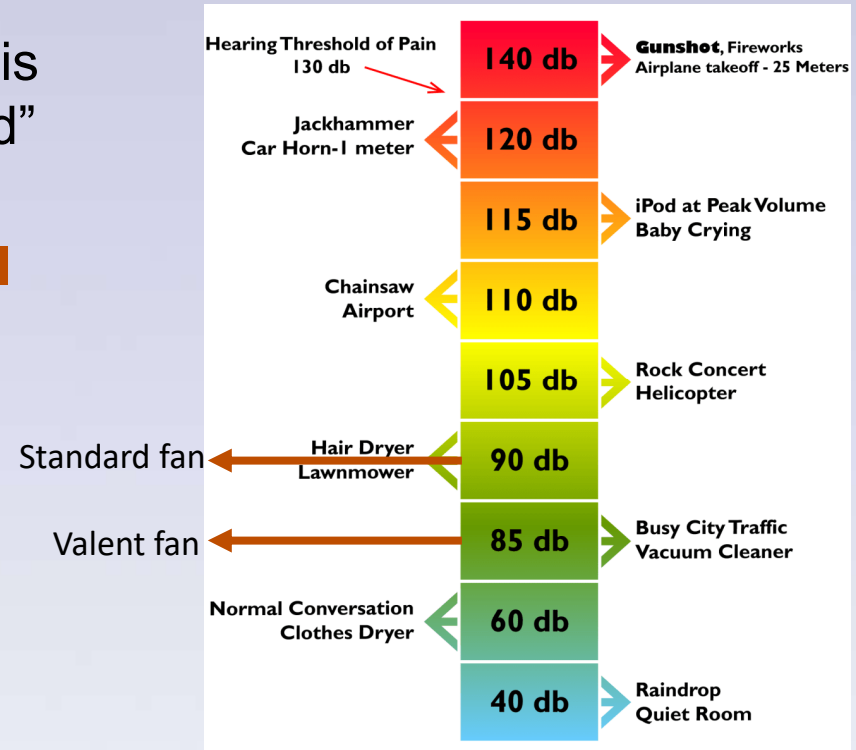
Condensing fans

Design

- Low-sound swept-blade design is 8-12 dB quieter than a “standard” fan

Improved Head Pressure Control

- One EC fan modulates
- All EC fans modulate



Head Pressure Control Options

- Standard Head Pressure Control
 - Condensing fans enable and disable via fixed pressure switches
 - Benefits
 - Simple
 - Least expensive
 - Drawbacks
 - Limits reheat capacity in part-load operation
 - Loud (one fan always at full speed)

Head Pressure Control Options

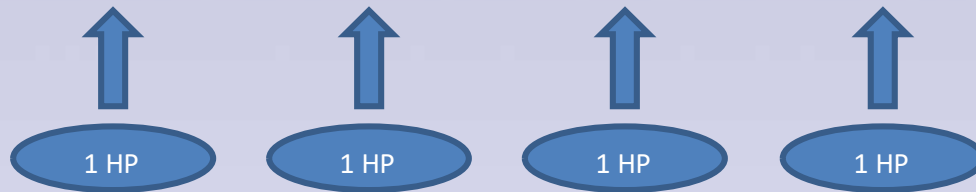
- Active Head Pressure Control 1.0
 - Single fan modulates via EC motor, fixed stages enable as needed
 - Benefits
 - Accurate control to a specific head pressure
 - Sound reduction at part load
 - Drawbacks
 - Sound reduction forgone when fixed fan enables

Head Pressure Control Options

- Active Head Pressure Control 2.0
 - Entire bank of modulating EC-driven fans
 - Benefits
 - Lower part load-sound
 - Increased condenser efficiency



Head Pressure Control - Example



Full condenser load
4 HP



50% condenser load
fixed stage fans
2 HP



50% condenser load
Variable speed fans
1/2 HP

Efficiency & codes!

- **NRCAN**
 - Sets federal energy efficiency regulations in absence of provincial direction
- **Ontario Electricity Act, 1998 (Amended July 1, 2019)**
 - **Ontario Regulation 509/18: Energy & Water Efficiency, Appliances & Products**
 - Schedule 4: Air Conditioning & Related Equipment

ii. Testing standard: CAN/CSA C746-17, Performance Standard for Rating Large and Single Packaged Vertical Air-Conditioners and Heat Pumps; with respect to the integrated energy efficiency ratio (IEER), ANSI/AHRI 340/360-2007, Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment. For air cooled air conditioners and heat pumps, U.S. DOE Code of Federal Regulations Part 431, Subpart F, §431.96 Uniform test method for the measurement of energy efficiency of commercial air conditioners and heat pumps may also be used, where applicable.



Consistent Efficiency Standards!

ASHRAE 90.1-2016

- O.Reg 509/18, DOE 431.96 & C746-17 are consistent

TABLE 1
LARGE UNITARY AIR CONDITIONERS

Column 1 Item	Column 2 Sub-type	Column 3 Heating type	Column 4 Cooling capacity	Column 5 EER	Column 6 IEER
1.	Air-cooled	A	≥19 kW and <40 kW	11.2	12.9
2.	Air-cooled	A	≥40 kW and <70 kW	11.0	12.4
3.	Air-cooled	A	≥70 kW and <223 kW	10.0	11.6
4.	Air-cooled	B	≥19 kW and <40 kW	11.0	12.7
5.	Air-cooled	B	≥40 kW and <70 kW	10.8	12.2
6.	Air-cooled	B	≥70 kW and <223 kW	9.8	11.4

** Note: For the purposes of Column 3, "A" means either no heating section or an electric heating section and "B" means a heating section other than an electric heating section. |*

Testing Standards: CAN CSA C746-17 or DOE Part 431.96

Reference Testing Standards

Large Air Conditioners (65-760 MBH)

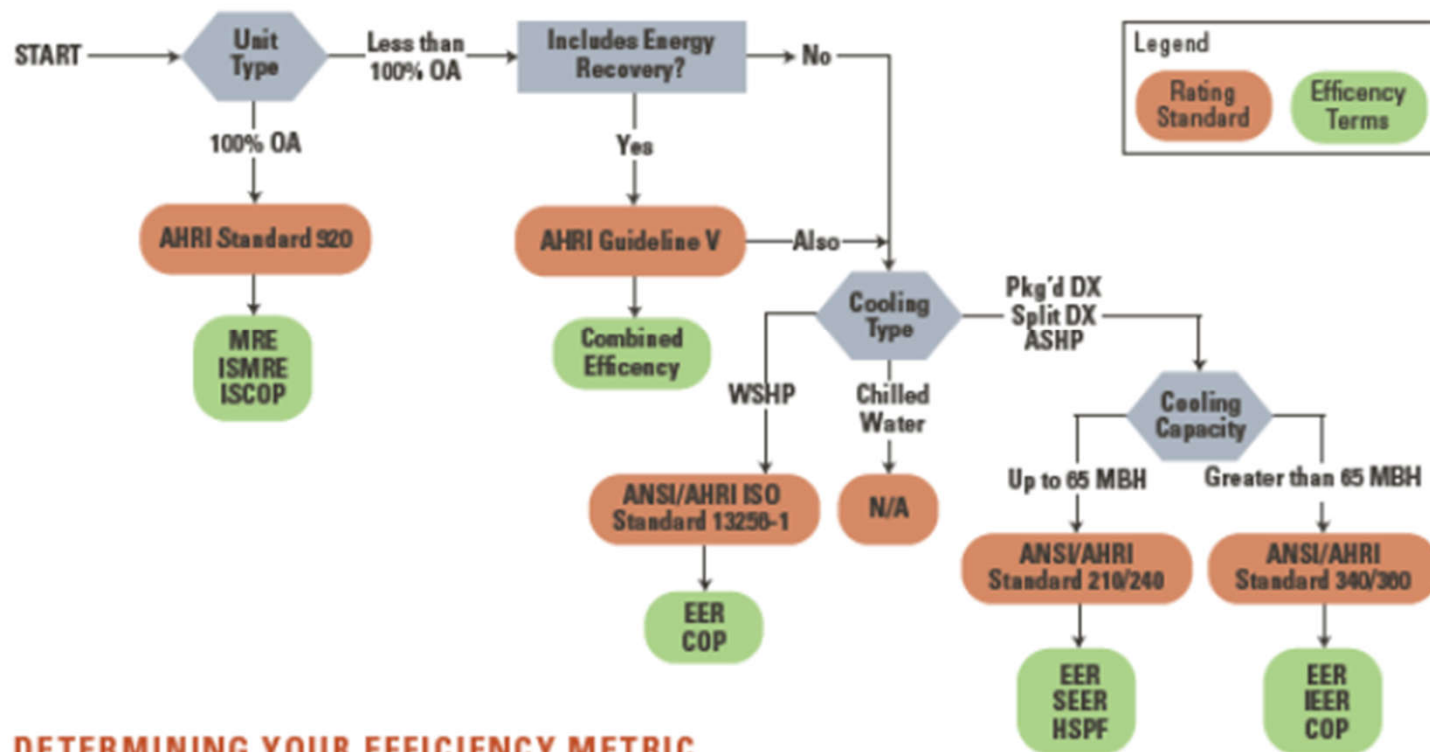
C746-17: Performance standard for rating large and single packaged vertical *air conditioners* and *heat pumps*

DOE Part 431.96: Uniform test method for the measurement of energy efficiency of commercial *air conditioners* and *heat pumps*.

- Table 1 – Test Procedures for Commercial Air Conditioners & Heat Pumps

Valent Testing Standards

INDUSTRY STANDARDS



DETERMINING YOUR EFFICIENCY METRIC

Valent Compliance

- DOE Compliance to AHRI 210/240
 - Air-cooled < 5 tons
- DOE compliance to AHRI 340/360
 - Air cooled 5 - 63 tons
- DOE compliance to ISO 13256
 - WSHP < 11 tons



DOAS Equipment

Intertek

Date: 10/26/15

Intertek
3933 US Route 11
Cortland, NY 13045-9717

Telephone: (607) 753-6711
Facsimile: (607) 753-7560
www.intertek.com

Phone: (204) 586-8565
Fax: (204) 589-7682

Subject: Dedicated Outdoor Air Systems (DOAS) and Performance Testing

Dear Mr. _____

The CSA C746 standard is the *Performance Standard for Rating Large and Single Packaged Vertical Air Conditioners and Heat Pumps*. This standard defines a commercial and industrial unitary air conditioner or heat pump as:

A factory-made assembly that normally includes an indoor conditioning coil, an air-moving device, one or more compressors, and one or more outdoor coils. In the case of an air conditioner, it can include a heating function in addition to the cooling function. In the case of a heat pump, it can include a cooling function in addition to the heating function.

Notes:

By definition equipment that operates at 100% outside air is considered a DOAS unit and is not covered under AHRI 340/360 or CSA C746. At this time AHRI doesn't have a program for this product, nor is there a lab available capable of achieving the conditions specified in the AHRI 920 standard.

In contrast, the AHRI standard that applies specifically to DOAS is AHRI Standard 920 the *Performance Rating of DX-Dedicated Outdoor Air System Units*. The scope of this standard specifically states that it excludes products covered under ANSI/AHRI Standard 210/240, ANSI/AHRI Standard 340/360, and ANSI/AHRI/ASHRAE ISO Standard 13256-1. The standard defines a DOAS as follows:

DX-Dedicated Outdoor Air System Units (DX-DOAS Units): A type of air-cooled, water-cooled, or water source factory assembled product which dehumidifies 100% Outdoor Air to a low dew point, and includes reheat that is capable of controlling the supply dry-bulb temperature of the dehumidified air to the designed supply air temperature. This conditioned outdoor air is then delivered directly or indirectly to the Conditioned Space(s). It may pre-condition Outdoor Air by containing an enthalpy wheel, sensible wheel, desiccant wheel, plate heat exchanger, heat pipes, or other heat or mass transfer apparatus.

Note: DX-DOAS Units can operate in combination with a separate sensible cooling system to satisfy the entire building humidity load. The system is sized to maintain a prescribed ventilation rate under any load condition. The ventilation rate can be constant or varied based on the building operation or occupancy schedule or in response to the actual occupancy. It may pre-condition Outdoor Air by incorporating an enthalpy wheel, sensible wheel, desiccant wheel, plate heat exchanger, heat pipes or other heat or mass transfer apparatus. It shall reheat the ventilation air by containing a reheat refrigerant circuit, sensible wheel, heat pipe, or other heat or mass transfer apparatus. Cooling components may include chilled water coils. Heating components are optional and may include electrical resistance, steam, hot water, or gas heat. In addition, it may provide for air cleaning

By definition equipment that operates at 100% outside air is considered a DOAS unit and is not covered under AHRI 340/360 or CSA C746. At this time AHRI doesn't have a program for this product, nor is there a lab available capable of achieving the conditions specified in the AHRI 920 standard.

Regards,



Tim Dovi
Engineering Team Lead

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- 100% outside air is not covered under AHRI 340/360 or CSA C746
- AHRI 920 is applicable

- Currently labs not capable of performing test

Webinar Take-aways

- DOAS present unique loads
- Valent is a robust, feature rich air handling solution
 - Efficient
 - Effective temperature **AND** humidity control
 - Configurable
- CSA C746 & DOE 431.96 are both applicable efficiency standards

Testing?





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E: nathan@odellassoc.com

Refrigeration Systems

- Scroll Compressor Basics
- Part Load / Modulation Techniques:
 - Compressor Technologies
 - Multiple Stages
 - Hot Gas Bypass
 - Digital scroll compressors
 - Inverter scroll compressors
 - Head pressure control



DOAS Definition - ASHRAE

“A dedicated outdoor air system (DOAS) **uses separate equipment to condition all of the outdoor air** brought into a building for ventilation... **and delivers it to each occupied space**, either directly or in conjunction with local or central HVAC units serving those same spaces.”



What about installation?

- Good solutions go beyond product features
- Quality products should:
 - Be readily available
 - Ship on time
 - Be easy to install
 - Work well
 - Be easy to maintain

SIMPLE
START-UPS

SHORT
LEAD
TIMES

AFFORDABLE
QUALITY

Simple Start Ups

Extensive factory testing and pre-configured controls make start up as easy as:

1. Inspect
2. Enable
3. Adjust

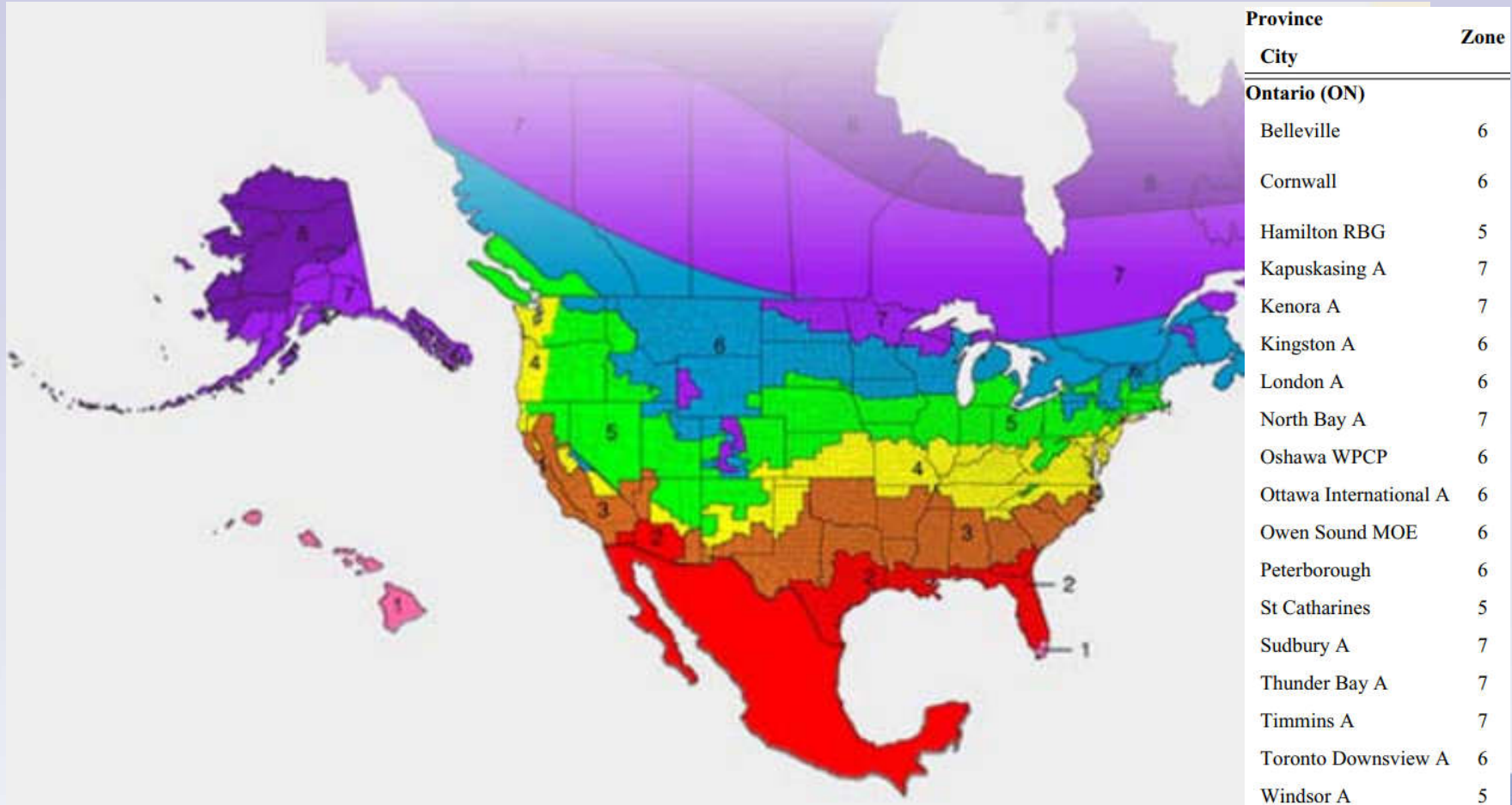
OPERATING TEMPERATURES AND PRESSURES				CIRCUIT A	CIRCUIT A (100% REHEAT)	CIRCUIT B	CIRCUIT B (100% REHEAT)
DISCHARGE PRESSURE							
HIGH GAGE TEMPERATURE							
HIGH PIPE TEMPERATURE							
SUBCOOLING							
LIQUID PRESSURE							
LOW GAGE TEMPERATURE							
LOW PIPE TEMPERATURE							
SUPERHEAT							
SIGHTGLASS							
COIL TEMPERATURE							
OUTDOOR AIR TEMPERATURE							
SUPPLY TEMPERATURE							
TOTAL REFRIGERANT CHARGE							
COMPRESSOR AMPS	CIRCUIT	RATED	A	B	C	PRE	NOTE
COMPRESSOR 1	CIRCUIT A						
COMPRESSOR 2							
COMPRESSOR 3							
COMPRESSOR 4							
HEAT PUMP HEATING MODE	CIRCUIT A (100% REHEAT)	CIRCUIT B	NOTES				
SUBCOOLING							
SUPERHEAT							
SIGHTGLASS							
OUTDOOR AIR TEMPERATURE							
SUPPLY TEMPERATURE							
TEST COMPLETION							
RUN UNIT IN AUTO FOR 5 MIN. NO ALARMS	<input type="checkbox"/>	HANDHELD DISPLAY TESTED/ALL BUTTONS WORK	<input type="checkbox"/>				
SHIPPING CHECKLIST							
FILTERS IN PLACE	<input type="checkbox"/>	COMPRESSORS BRACED	<input type="checkbox"/>				
FILTER HOLDERS IN PLACE	<input type="checkbox"/>	CONDENSER FAN SCREWED DOWN	<input type="checkbox"/>				
EXTRA FILTERS IN UNIT - Part #s and quantity below	<input type="checkbox"/>	FURNACE INTAKE HOOD COVERS TIGHT	<input type="checkbox"/>				
EXTRA PIN	QTY	EXTRA PIN	QTY				
		DOUBLE-CHECK PICK LIST	<input type="checkbox"/>				
		COMPRESSOR BOLTED DOWN	<input type="checkbox"/>				
		CAPS ON VALVES	<input type="checkbox"/>				
		TIE BACKS INCLUDED	<input type="checkbox"/>				
EXTRA FILTERS SHIPPED LOOSE - Part #s and quantity below	<input type="checkbox"/>						

The screenshot displays the Valent web interface for a unit. At the top, it shows 'Job Name: UCTProductCenter', 'Unit Tag: RTU-4', and 'SO Number: 6675679_20'. The main dashboard includes several data cards: 'Set Setpoint' (55.0°F), 'Active Setpoints' (Supply: 55.0°F, Cooling Coil: 50.0°F), 'Outside Conditions' (Temperature: 77.5°F, Humidity: 54.9%RH), 'Cooling Detail' (Cooling Capacity: 44%, Compressor 1: Off, Compressor 2: On), 'Heating Detail' (Heating Capacity: 0%, Furnace 1: 0%), 'Supply Conditions' (Temperature: 54.8°F), and 'Inside Conditions' (Temperature: 71.2°F, Humidity: 60.0%RH). A 'Heat Pump Detail' card shows 'Reversing Valve: Cooling' and 'HP Heat Capacity: 0%'. Below these are 'Pop-up Tools' like 'Live Trend', 'Unit Display', 'Dewpoint Calculator', and 'Upgrade Application'. A central graphical diagram shows the unit's internal components with labels for 'OUTSIDE AIR', 'EXHAUST AIR', 'RETURN AIR', and 'SUPPLY AIR'. A green callout box states: 'Clear and intuitive web page provides visibility to unit operation during start up and/or daily operations.' Another callout says: 'Quickly and easily see the current state of the unit as conditions change.' A third callout notes: 'Pre-programmed, graphical web page included with ALL Valent/Immovent units'.

Short Lead Times

- Normal lead times are 6 weeks
 - COVID is impacting this right now
- Quick-build options can shorten lead times
- Our goal is to deliver Valent when you need it
- **98% on-time shipment in 2019**

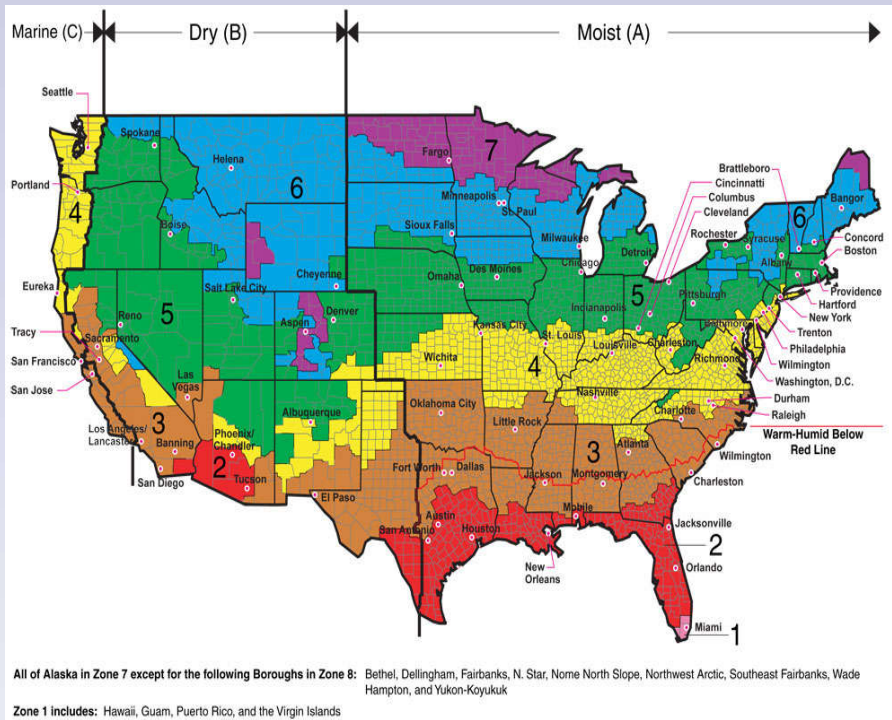
ASHRAE 90.1 Requirements



Exemptions to 90.1

- Lab exhaust
- Spaces that are not cooled and not heated to more than 60°F.
- Systems exhausting toxic, flammable, paint, corrosive fumes or dust
- When 60% of the outdoor air heating is provided from site-recovered or site-solar energy
- Commercial kitchen exhaust
- Systems operating <20 hrs/week at OA percentage covered by table 6.5.6.1

ASHRAE 90.1 Requirements



6.5.6.1 Exhaust Air Energy Recovery.

An energy recovery system is required when the system's supply airflow exceeds the value listed in Table 6.5.6.1 based on **climate zone** and **percentage of outdoor air flow rate** at design conditions.

Energy recovery systems required (by table 6.5.6.1) shall have at least **50% recovery effectiveness**. (This shall mean a **change in the enthalpy** of the **outdoor air** supply equal to 50% of the difference between the **outdoor air** and return air enthalpies at design conditions.

Table 6.5.6.1 Energy Recovery Requirement						
Zone	% Outdoor Air at Full Design Airflow Rate					
	≥30% and >40%	≥40% and >50%	≥50% and >60%	≥60% and >70%	≥70% and >80%	≥80%
	Design Supply Fan Airflow Rate (cfm)					
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	≥5,000	≥5,000
1B, 2B, 5C	NR	NR	≥26,000	≥12,000	≥5,000	≥4,000
6B	≥5,500	≥4,500	≥4,500	≥3,500	≥2,500	≥1,500
1A, 2A, 3A, 4A, 5A, 6A	≥5,500	≥4,500	≥3,500	≥2,000	≥1,000	≥0
7, 8	≥2,500	≥1,000	≥0	≥0	≥0	≥0

Zone 4A - Requirements:

- Energy Recovery on many system applications
- Minimum energy recovery Efficiency requirements

Exemptions to 90.1

- Lab Exhaust (meeting 6.5.7.2)
- Spaces that are not cooled and not heated to more than 60 deg F
- Systems exhausting toxic, flammable, paint, corrosive fumes or dust
- When 60% of the outdoor air heating is provided from site-recovered or site-solar energy
- Systems operating less than 20 hrs per week at the outdoor air percentage covered by table 6.5.6.1

Valent Designed for DOAS Applications



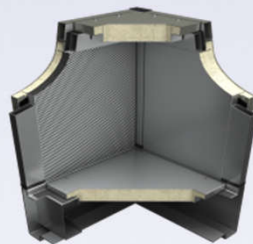
Casing

Construction

- Standard: 2" R13 double-wall construction (walls, doors, and roof!)
- Option: Aluminum or Stainless Steel Interior

Duct flexibility

- Bottom or side standard
- Option: Top



Valent VPR-352

Casing Size Overview

		VX, VXE CASING				VPR, VPRX, VPRE, VPRP, VPRC CASING				
		112	212	311	352	V10	110	210	310	352
AIRFLOW	Minimum ^a (cfm)	800	2,250	4,000	3,900	550	645	1,290	3,225	3,900
	Maximum ^a (cfm)	5,750	9,500	13,500	18,000	3,000	4,300	8,000	12,100	18,000
Packaged, air cooled	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
	5	15	25	30	4	5	10	25	30	
	7.5	17.5	30	40	5	8	13	30	40	
	10	20	35	50	6	10	16	35	50	
	12.5	25	45	60	7	—	18	40	60	
	15	30	—	70	—	—	20	—	70	
	—	—	—	—	—	—	25	—	—	
INDIRECT GAS FURNACE	Minimum (MBh)	100	300	200	600	75	100	200	400	600
	Maximum (MBh)	300	500	800	1,200	200	200	400	800	1,200
	Turndown (NG)	Up to 16:1	Up to 16:1	Up to 16:1	Up to 10:1	Up to 10:1	Up to 10:1	Up to 10:1	Up to 10:1	Up to 10:1
	Turndown (LP)	Up to 16:1	Up to 16:1	Up to 16:1	Up to 6:1	Up to 6:1	Up to 6:1	Up to 6:1	Up to 6:1	Up to 6:1

Types of Heating

- Air-source heat pump
- Water-source heat pump
- Hydronic – HW or Steam
- Electric heat
 - SCR controlled modulating
- Indirect gas furnace
 - 4:1 or 10:1 modulating turndown (15:1 in 350 casing)
 - 409 SS tubes standard
- Temperator (hybrid)

Types of Cooling

- Air-cooled DX – Packaged and Split
 - Packaged: 4 to 70 tons
 - Split Condenser: to 5 to 40 tons
- Water-source heat pump
 - 5 to 60 tons
- Air-source heat pump
 - 5 to 25 tons
- Chilled water
 - 5 to 60 tons