

#### **DOAS Solutions**













Life's Good

E-mail

#### **DOAS Solutions**

- Agenda
  - DOAS definition
  - Code requirements
  - DOAS system types
  - Energy studies
  - Case studies
  - Best practices
  - Mistakes to avoid



## DOAS Definition DEDICATED OUTDOOR AIR SYSTEMS



#### **ASHRAE** Definition

"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."

"ASHRAE Design Guide for Dedicated Outdoor Air Systems." 2017, 1-2.



#### **DOAS** Definition





#### PACKAGED DOAS



SPLIT DOAS

## Terminology

- DOAS
  - Unit providing all of the prescribed outdoor air to a single zone or to multiple zones
- Common DOAS names:
  - ERV
  - ERU
  - MUA
  - DOA
  - OAU
  - AHU



## Why use DOAS?

- Ensure good IEQ through properly ventilating all spaces
- Provide good humidity control
- Simplify ventilation design (ASHRAE 62.1 compliance) and control





#### **Psychrometrics Review**





# Design Considerations DEDICATED OUTDOOR AIR SYSTEMS



### **Code Requirements**

- 90.1 impacts to DOAS design are
  - Minimum equipment efficiencies
  - Fan power limitations
  - Economizer
  - Exhaust air energy recovery
  - Limitation on simultaneous heating & cooling
  - Do not reheat above 60F



### Minimum Equipment Efficiencies

- AHRI 340/360 is referenced by 90.1 but is for packaged rooftop units with 30% outdoor air (not DOAS)
- AHRI 920 is still in progress and has introduced MRE & ISMRE instead of EER/IEER for DOAS unit ratings



2015 Standard for Performance Rating of DX-Dedicated Outdoor Air System Units





#### Fan Power Limitations

- Typically 1.5 HP per 1k CFM when using variable flow
- Not a challenge with reasonable ESPs





### Simultaneous Heating & Cooling

Allowed when using waste heat like a hot gas reheat coil





# **Economizer & Energy Recovery**

- Both required in most zones
- Note of caution on effectiveness (ASHRAE and AHRI have different formulas)

The exchanger heat transfer effectiveness e is defined as the amount of energy recovered, e.g. sensible or latent, divided by the maximum amount of energy that could theoratically be recovered.

The supply air volume heat transfer effectiveness es is defined as

$$e_{\rm S} = \frac{V_{\rm S} (X_1 - X_2)}{V_{\rm min} (X_1 - X_3)}$$





## DOAS System Types DEDICATED OUTDOOR AIR SYSTEMS

# SPLIT DOAS



SPLIT TYPE SWEGON ERV with LG AHU Kit



# AHU KIT

LG AHU kit allows Outdoor (condensing) unit to be piped as far as 656 feet away from AHU

• Elevation difference up to 360 feet





# PACKAGED DOAS



- 5 to 70 tons
- Inverter compressor option



# OAU with VRF

#### 18 ton ODU





- 400 to 1200 CFM
- Minimum 23F entering air temp
- Reheat with standard indoor units







Air to air heat exchanger

- 400 1200 CFM
- Minimum entering air 14F





# Energy Studies DEDICATED OUTDOOR AIR SYSTEMS

### **Energy Studies**

Energy Modelling has shown up to 28% savings using Packaged DOAS with ERV over mixed OA system

Figure 3: LG Dedicated Outdoor Air Systems (DOAS).



(a) Split Type : VRF Condensing Unit with Split-Type DOAS Indoor Unit.



(b) Packaged Type.

Baseline and proposed HVAC systems were as follows:

Table 5: Air-Handling Mechanical System Characteristics.

	HVAC System		Baseline – No OA system	Proposed - LG Multi V + Split Type DOAS	Proposed - LG Multi V + Packaged DOAS	Proposed - LG Multi V + Packaged DOAS+ ERV		
6	Cooling	VRF (DX- Cooling)	150-200 Tons 15 EER	150-200 Tons 15 EER	150-200 Tons 15 EER	150-200 Tons 15 EER		
F	leating	VRF (Heat Pump)	4.5 COP	4.5 COP	4.5 COP	4.5 COP		
	Air Systems		Ducted Type VRF Indoor units	Ducted Type VRF Indoor units	Ducted Type VRF Indoor units	Ducted Type VRF Indoor units		
	OA Processing		15-20 Tons Direct inlet and mixed with RA	LG DOAS* Cooling:15 EER, 25 IEER Heating: 4.5 COP - Fan power	LG DOAS* Cooling:12.5 EER, 25 IEER Heating: Gas Furnace, ŋ = 80% - Fan power	LG DDAS* Cooling 12.5 EER, 25 IEER Heating: Gas Furnace, n = 80% Wheel Type Energy recovery ventilator Latent Effectiveness: 55% - Sensible Effectiveness: 65% - Fan power (Supply and Return Fans)		

#### Chicago Results (5A)

Energy consumption by end use for the Chicago location (Climate Zone 5A) was as follows:

Table 15: Chicago Annual Energy Consumption / Outdoor Air Conditioning Energy Cost Comparisons.

(1) Option A: Neutral temperature air.

System	Baseline		Proposed		Proposed			Proposed			
	(IMIXed OA)		<u>(</u> )	Savings		(Раскадео Тур		Savings	Гласка	zea ERV	Savings
	Energy	Cost	Energy	Cost	Over	Energy	Cost	Over	Energy	Cost	Over
					Baseline			Baseline			Baseline
	kBtu	\$	kBtu	\$	%	kBtu	\$	%	kBtu	\$	%
OA	167,207	4,460	119,860	3,197	28%	329,091	4,114	8%	97,045	1,639	63%
Primary	1,371,605	36,581	1,054,004	28,111	23%	1,058,813	28,240	23%	1,049,544	27,991	23%
Total	1,538,812	41,041	1,173,864	31,308	24%	1,387,903	32,354	21%	1,146,589	29,630	28%



(\*https://www.ahuidinectory.org/ahuidinectory/pages/vrfhp/defaultSearch.aspx.)

# Case Studies DEDICATED OUTDOOR AIR SYSTEMS



#### 1280 Peachtree, Atlanta





#### 40 Story Condo Building

- Replacement of 10,000 CFM DOAS AHU
- 64 tons Multi V IV
- 8 AHU kits
- Equipment could only be brought thru elevators





#### Quantum on the Bay, Miami



#### 238 Ton DOAS Replacement

• 36% Energy Savings using LG AHU kit with split DOAS units



Baseline system : Rooftop units (AAON)



Proposed system : LG Multi V 5 + LG EEV Kits + AAON AHU



#### LG Appliance Factory, Clarksville



#### 23 LG RT DOAS Units

- 800 Tons total
- Mix of 100% OA units and partial recirculation units







# Best Practices DEDICATED OUTDOOR AIR SYSTEMS



### Controls

- Built in Graphics
- Web based controller with IP address
- Easy to use
- Proven control sequences for reliability







#### Inverter Compressors

- Accurate capacity control
- Reduced energy consumption
- Quieter than digital scroll







#### Energy Recovery Wheel

- Reduces required cooling tonnage
- Reduces stress on compressors
- Built in rotation sensors with alarm
- Modulating (VFD) control for frost prevention





#### **Condenser Fan**

- Whisper quiet condenser fans
  - Low sound fan blades
  - 20 db quieter than standard condensing fans
  - AMCA rated sound data
  - Modulate lead condenser fan for head pressure control





### **Airflow Monitoring**

- Factory installed airflow monitors
  - Fan inlet cone
  - OA damper
  - Airflow rates visible at the controller







#### **Compressors on raised platform**

• Lower noise and vibration than mounting on floor







### System Controls





### Side Discharge Configurable

• Side return/discharge option on LG unit



• Other manufacturers require tall plenum curbs





#### End of Line Tested

- Units are run tested at factory for minimum 60 min
- Tests reports available upon request







# Mistakes to avoid **DEDICATED OUTDOOR AIR SYSTEMS**



#### Do Not use ERV as primary DOAS

Virginia School called complaining of high humidity levels

- ERV discharge was ducted into the building at 85.5F DB/72.5F WB without cooling the air to remove humidity
- System had to be retrofitted to add cooling coil and condenser









#### Avoid LAT below 50F

Packaged DX works well down to 50F LAT in dehumidification

- Sub 50F LAT may require chillers or custom equipment, adding costs
- Minimize energy efficiency by not oversizing compressor





### **Do Not Modify Packaged Controls**

Packaged DOAS Controls cannot be modified to communicate to VAV boxes

• BMS system was VE'd out of the project







## Local LG Support DEDICATED OUTDOOR AIR SYSTEMS

#### Wadsworth Solutions

Bart Barry – Vice President Ph. 216/391-7263 M. 216/645-1658 E: bbarry@wadsworthsolutions.com Nestor Antonio Espana Ph. 216/391-7263 M. 216/906-6876 E: nespana@wadsworthsolutions.com







- Founded in 1944
- \$65,000,000 in annual sales
- 145 employees
- · Family owned and second generation
- Tremendous relationships with Engineers and MCs
- Toledo, Cleveland, Youngstovm, and Detroit







### Wadsworth Solutions

#### Wadsworth Solutions

"Providing Solutions for Secure, Energy Efficient Environments"

•Diverse company that provides many in-building solution

- •Holistic approach to identifying and solving client's need.
- •Technology based organization with highly skilled and trained staff members

•Strength continues to be the dedication and integrity of our personnel



Building Automation











#### Wadsworth Solutions





