QLCI™ Designed by TROX®

Displacement Induction Ventilation Application Guide

CARSON SOLUTIONS™

www.carsonsolutions.com

v2.0 – Issue Date: 11/2022

Introduction	**3**
Basics of Displacement Ventilation	**3**
Ventilation Building Blocks	**4**
Mixed Air Systems	4
Displacement Ventilation Systems	5
The Differences	6
All Displacement Ventilation is NOT Equal	**7**
QLCI Operation Basics	7
Differences between DIV and TDV	8
Validation and Excerpts from Experts	9
Typical Applications for QLCI Equipment	**11**
Cornerstone of a Winning HVAC System	12
The Design Challenges Addressed	13
The Benefits Delivered	**14**
IAQ	14
Energy Efficiency	15
Quiet Acoustics	16
Thermal Comfort	17
Reduced Maintenance	18
Putting the Architectural Pieces Together	**19**
Typical Room Layout Configurations	20
Customizable to Meet Your Needs	21

INTRODUCTION

Ventilation of indoor spaces is critical for the health and well-being of the occupants, and operational needs of the spaces within the buildings. ASHRAE 62.1 defines the guidelines used for "Acceptable Indoor Air Quality." Many of the established practices used within this QLCI Application Guide are based on ASHRAE 62.1 guidelines. Designers should reference and apply ASHRAE 62.1 as well as local design codes in close conjunction with this QLCI Application Guide.

By following the QLCI Application Guide, the user will step through the basics of Displacement Induction Ventilation, the critical concepts of differing ventilation system types, typical HVAC mechanical components applied to the system, the critical benefits the QLCI delivers to classrooms, students and school districts, and finally see how the solution comes together in an architecturally pleasing manner. While this guide references classrooms as the example, the QLCI can be applied to a wide variety of spaces including higher education learning centers, dormitory rooms, healthcare environments, casinos, and any environment that needs improved indoor air quality.

UNDERSTANDING THE BASICS OF DISPLACEMENT VENTILATION

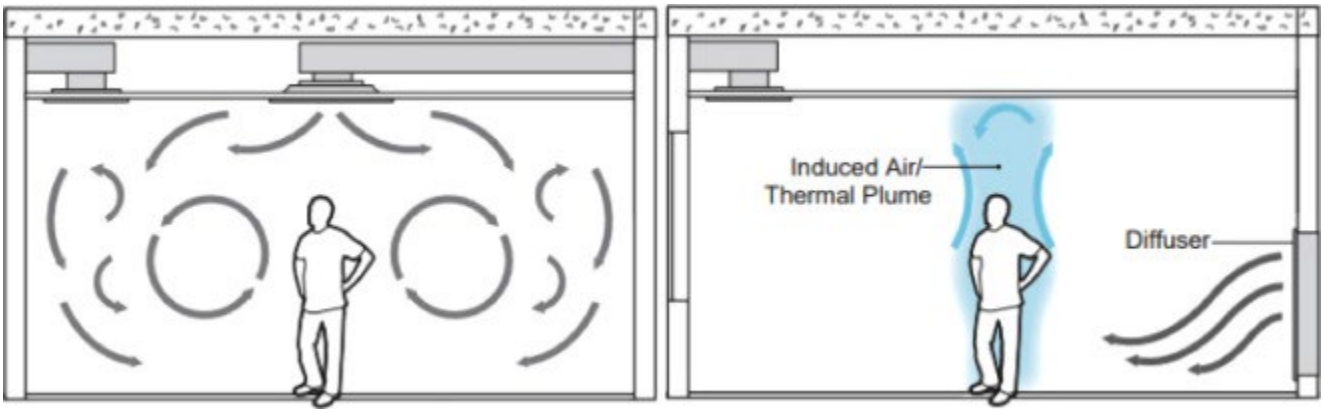
Displacement Ventilation is a tested and verified HVAC air distribution method for occupied spaces. Air is introduced to the space low, near floor level at a lower velocity that traditional HVAC systems. The air then travels across the room until it meets a heat source – typically an occupant. The air then travels upward along the occupant's body via convective currents, or thermal plumes, directly to their immediate breathing areas. The thermal plumes continue upward above the occupied space and are then exhausted out of the space at, or near, ceiling-level. This process of the air rising along the heated body is due to the buoyancy force. The less dense, hotter air is more buoyant causing the air to rise above the occupant's head.

Traditional buildings have mixed air ventilation systems installed. These types of systems introduce air at or near the ceiling and push the air down onto the occupants. Because the air is continually being mixed, the pollutants and contaminants of the room are also continually being circulated back amongst the occupants. Unlike mixed air ventilation, as the air rises during displacement ventilation the airborne contaminants and pollutants also rise to the ceiling and are immediately extracted out of the room, so the occupants have considerably less exposure to recycled, contaminated air.

EXAMPLE ROOMS:

MIXED AIR VENTILATION

TRADITIONAL DISPLACEMENT VENTILATION

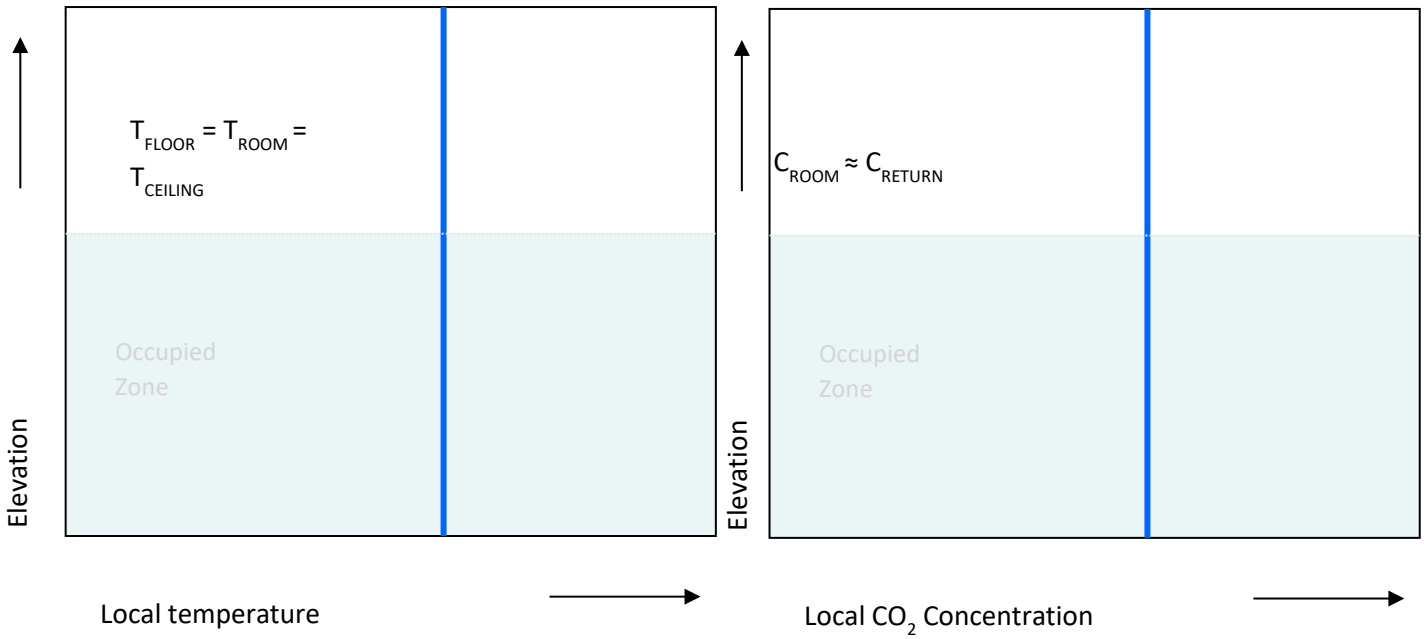


VENTILATION BUILDING BLOCKS

Understanding the differences between the main types of ventilation distribution types: Mixed Air Ventilation and Displacement Ventilation.

MIXED AIR DIFFUSER:

DESIGN OBJECTIVE:



MIXED AIR DIFFUSER: OPERATION AND DESIGN CHARACTERISTICS

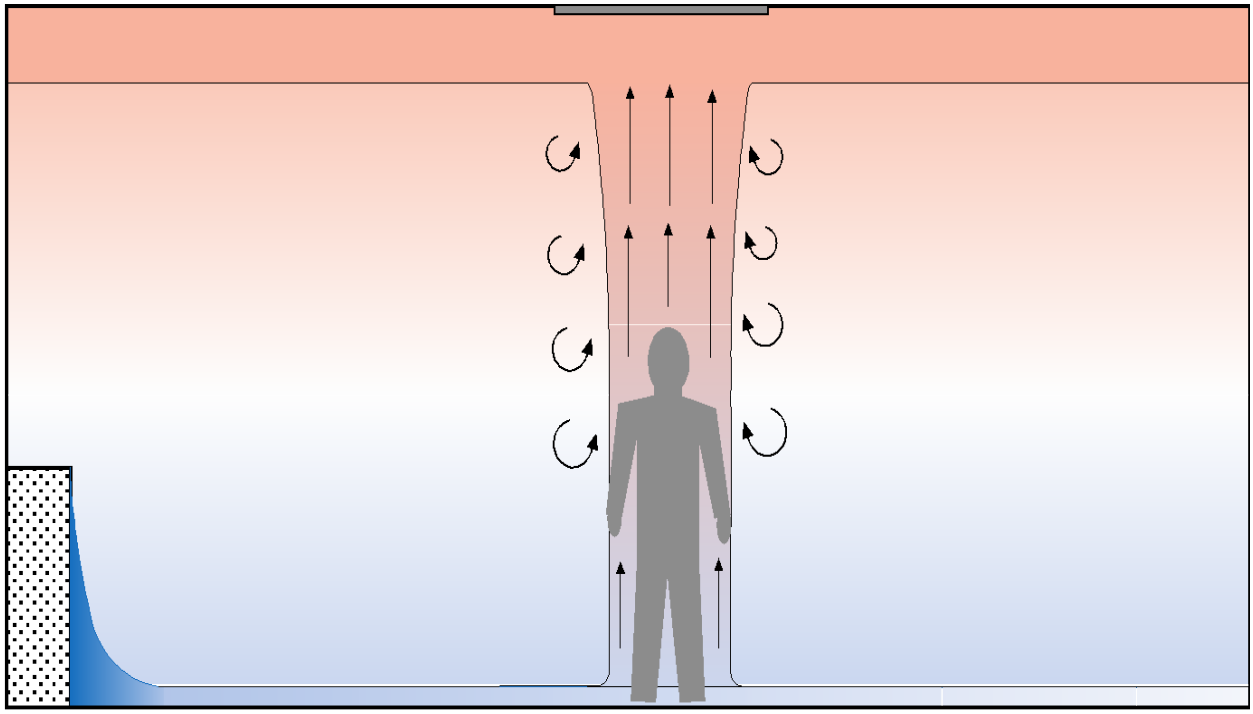
- Distribute supply air across ceiling
- Maintain velocity throughout space to promote mixing of the supply and room air
- Provide uniform temperature distribution throughout entire room space, floor to ceiling
- Provide uniform contaminant levels throughout entire room space, floor to ceiling
    - $E_z = C_{ret} - C_s / C_{rm} - C_s$
    - $C_{rm} = C_{ret}$
    - E_z* = 1 at optimum operation for a mixed air system in cooling
- Typical supply air discharge temperature in cooling ~ 55°F
- Typical supply air discharge temperature in heating ~ 85°F – 90°F

**** More to follow on E_z see ASHRAE 62.1-2019 Table 6-4***

VENTILATION BUILDING BLOCKS

Understanding the differences between the main types of ventilation distribution types: Mixed Air Ventilation (Figure 1) and Displacement Ventilation (Figure 2).

DISPLACEMENT VENTILATION: DESIGN OBJECTIVE



DISPLACEMENT VENTILATION DIFFUSER: OPERATION AND DESIGN CHARACTERISTICS

- Supply air delivered low or near the floor level
- Supply air velocity much lower than traditional mixed air diffuser
- Supply air temperature more temperate than mixed air system but slightly below room temperature setting causes more dense air to stay at floor level
- Creates a small temperature gradient (<5.4°F) between occupants' feet to head in order to meet ASHRAE 55 for Thermal Comfort
- Creates subsequent contaminant gradient where dirtiest air rises to the unoccupied zone then exhausted

ALL DISPLACEMENT VENTILATION IS NOT CREATED EQUAL!

QLCI: THE COMBINATION OF DISPLACEMENT VENTILATION AND INDUCTION OPERATION

UNDERSTANDING THE DIFFERENCES: Types of Air Distribution

Nearly all schools currently use the mixed-airflow method for distribution and dilution of the air within the occupied space. "Designers should investigate a method called vertical displacement ventilation or thermal displacement ventilation. This approach successfully uses natural convection forces to reduce fan energy and carefully lift air contaminants up and away from the breathing zone."

SCAN OR CLICK
Learn more from the EPA website

MIXED AIR SYSTEMS

IAQ aspects

- $E_z \leq 1$
- Only approach to "improve" IAQ is to increase air flow or add improved filtration which increase system TSP and operating costs
- Must address entire room volume load to insure "mixing" and uniform temperatures and contaminant levels
- Contaminants "linger" and become diluted versus being removed quickly

Acoustics

- Air moving devices in or near occupied zones
- Background noise typically 40 – 55 dBA

Maintenance

- Air moving devices such as compressors, fans, motors, dampers, filters in zone
- Subsequently need routine maintenance and repair

Thermal Comfort

- Cooler temperature delivered in cooling
  - Typically 55°F
- Greater temperature difference between supply and room temperature setting
- Higher diffuser discharge velocities
- Cooler temps and high velocities result in occupant sensation of "draft"

TRADITIONAL DISPLACEMENT VENTILATION SYSTEMS

IAQ aspects

- E_z ranges from minimum of 1+ to 1.2
- Inherently provides improved IAQ as E_z indicates contaminant removal efficiency
- Focused on occupied zone only to deliver fresh air directly to occupants
- Contaminants are immediately removed from occupied zone

Acoustics

- NO air moving devices in zones
- Background sound below 35 dBA

Maintenance

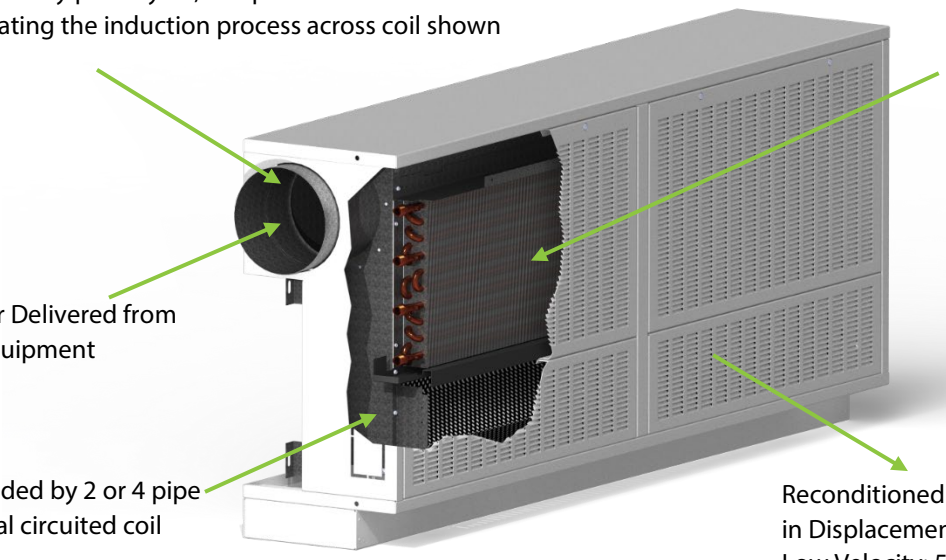
- NO air moving devices such as compressors, fans, motors, dampers, filters in zone
- VERY LIMITED routine maintenance and repair

Thermal Comfort

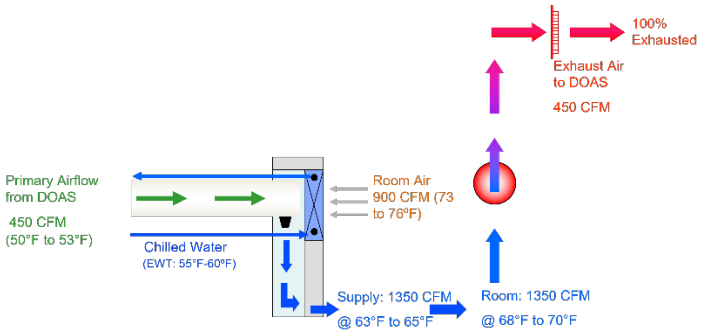
- Warmer temperature delivered in cooling
  - Typically 62-65°F
- Smaller temperature difference between supply and room temperature setting
- Low diffuser discharge velocities
- Warmer temps and low velocities result in little "draft" effect

OPERATIONAL BASICS OF THE QLCI DISPLACEMENT INDUCTION DIFFUSER

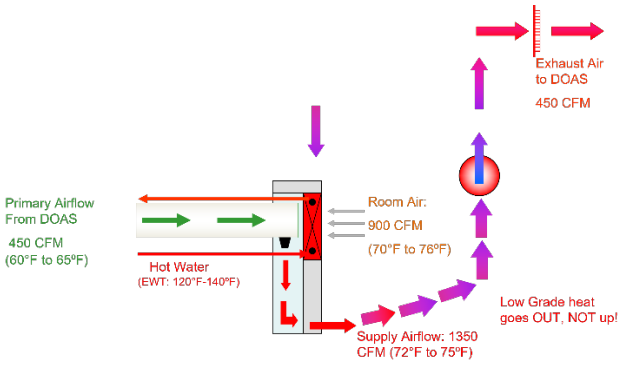
As plenum is pressurized by primary air, low pressure induction occurs via a series of nozzles creating the induction process across coil shown



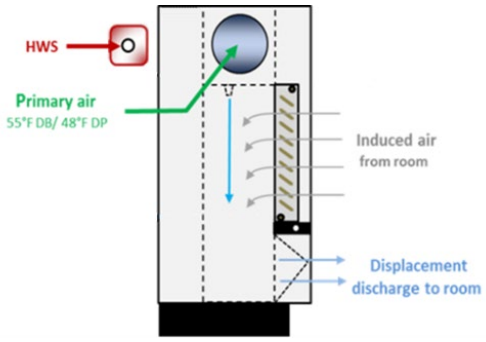
Operation Schematic - Typical Cooling Mode:



Operation Schematic - Typical Heating Mode:



Optional Heating Approach: Integration of Radiant Finned Tube



ALL DISPLACEMENT VENTILATION IS NOT CREATED EQUAL!

QLCI: THE COMBINATION OF DISPLACEMENT VENTILATION AND INDUCTION OPERATION

DISPLACEMENT INDUCTION VENTILATION SYSTEMS

Single System in Zone

- Ventilation provided from diffuser
- Sensible cooling delivered from diffuser
- Sensible heating delivered from diffuser
- Contaminants are immediately removed from occupied zone

IAQ

- Cooling: Stratified => E_z 1.2 - 1.3
- Heating: Stratified => E_z 1+ - 1.2+

Thermal Comfort and Space Usages

- Supply air discharge low to floor
  - No near zone recognized
  - Occupants can sit next to diffuser
  - MAXIMIZES usable floor space

Air Transportation & System Efficiencies

- DOAS air flow 1/3 the CFM compared to AHU for traditional displacement
  - Smaller air handler
  - Smaller fan / motor
  - Smaller FLA, MCA
  - Smaller SA and EA ductwork
- Space load BTUs used for reheat in zone or "recovered" via energy recovery

TRADITIONAL DISPLACEMENT VENTILATION SYSTEMS

Multiple System Types in Zone

- Ventilation provided from diffuser
- Sensible cooling delivered from diffuser
- SEPARATE component or system needed to address heating such as radiant panel or finned tub
- Heating cannot be supplied via diffuser
- Contaminants are immediately removed from occupied zone

IAQ

- Cooling: Stratified => E_z 1.2
- Heating: Mixed => E_z < 1.0
- Heating radiant heat: Mixed => E_z <1.0

Thermal Comfort and Space Usage

- Diffuser ~ 4' high, supply requires distance to "drop" to floor
  - NEAR ZONE areas created; occupants need to be a certain distance away from diffuser for "draft" concerns
  - LIMITS usable floor space

Air Transportation & System Efficiencies

- Full CFM needed to address ventilation and room loads
  - Full sized air handler
  - Increased fan / motor
  - Increased FLA / MCA
  - Increased SA and RA ductwork
- Space loads picked up, transported to air handler, treated, and cycle continues

ALL DISPLACEMENT VENTILATION IS NOT CREATED EQUAL!
QLCI: THIRD PARTY LAB TESTING AND VERIFICATION OF BETTER IAQ

PURDUE SUBSTANTIATES QLCI OPERATION OF YEAR-ROUND DISPLACEMENT VENTILATION

Questions continue to arise surrounding the correct value to apply for ventilation effectiveness, Ez, when determining code required minimum outside air per Table 6-4, ASHRAE 62.1-2019. In Table 6-4, ASHRAE outlined default values based upon distinct ventilation type and finite operational characteristics.

> "The committee is considering an addendum which would permit calculation of Ez for more complicated systems and control strategies."
>
> - Excerpt from ASHRAE interpretation response 2/14/19

ASHRAE recognized the default values in Table 6-4 could not capture the myriad of ventilation and equipment designs, not to mention the enhanced control strategies, applied in industry practice.

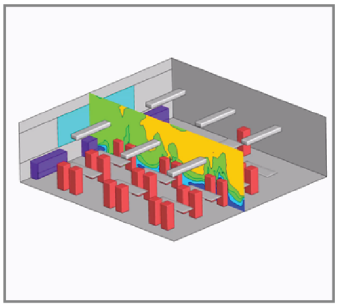


Figure 1: Simulation of QLCI Displacement Ventilation in HEATING mode.

Normative Appendix C defines the procedure for determining zone distribution effectiveness through the following measures: (1) CFD modeling coupled with supporting lab validated testing and (2) operational performance must be measured in BOTH cooling and heating modes.

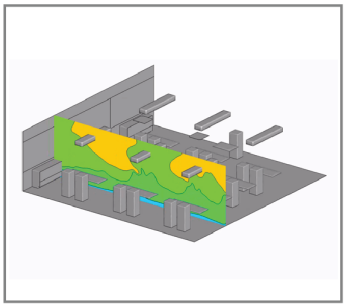


Figure 2: Simulation of QLCI Displacement Ventilation in COOLING mode.

In Table 6-4, for Stratified Air Distribution Systems, (Displacement Ventilation) the Ez default values were only defined for cooling mode operation. Now with the defined procedures per Normative Appendix C, the ability to establish Ez values for Displacement Ventilation during heating modes can now be applied.

Purdue University tested the QLCI per the Normative Appendix C procedures. The static CFD models, Figure 1 (Heating Mode) and Figure 2 (Cooling Mode), clearly show and prove Carson Solutions QLCI delivered stratified room conditions in both cooling and heating modes. With this validated testing, unique only to Carson Solutions' QLCI, designers can confidently apply Ez values greater than unity year-round.

PURDUE UNIVERSITY® | RAY W. HERRICK LABORATORIES

ALL DISPLACEMENT VENTILATION IS NOT CREATED EQUAL!

QLCI: EXCERPTS FROM EXPERTS ON THE DISPLACEMENT INDUCTION VENTILATION BENEFITS

ASHRAE VIRTUAL ANNUAL CONFERENCE
June 28-30, 2021

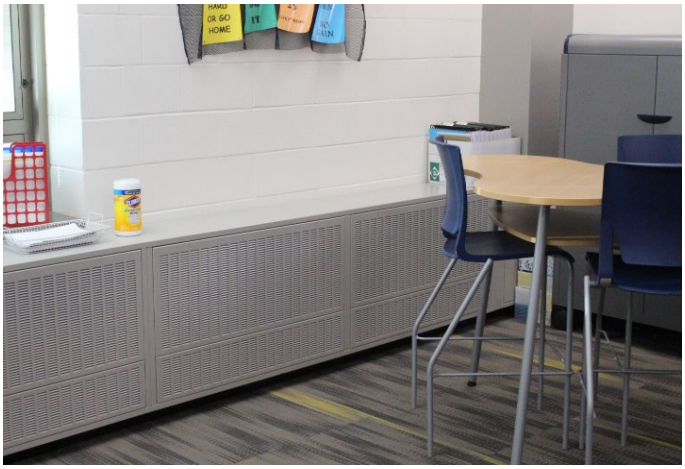
"Wall-Mounted Displacement Induction Ventilation System for Reducing Virus Transmission in Classrooms. Based upon Purdue University's lab and CFD research of the QLCI (DIV) diffuser

- DIV system created stratified air distribution in cooling mode. Its VE was shown to be higher (E_z =1.3) than that of a corresponding traditional DV (E_z = 1.2) with the same percentage of return air.
- In heating season, staged-face heating mode of DIV system created stratified contaminant distribution which remedied the limitation of traditional DV.
- The alternative rear heating mode also produced stratified air distribution in indoor environment.
- Particles with small diameters exhibit similar distribution as gaseous contaminants. Hence, the stratified air conditions demonstrated in this study could be also used to describe its effectiveness in removing particles."

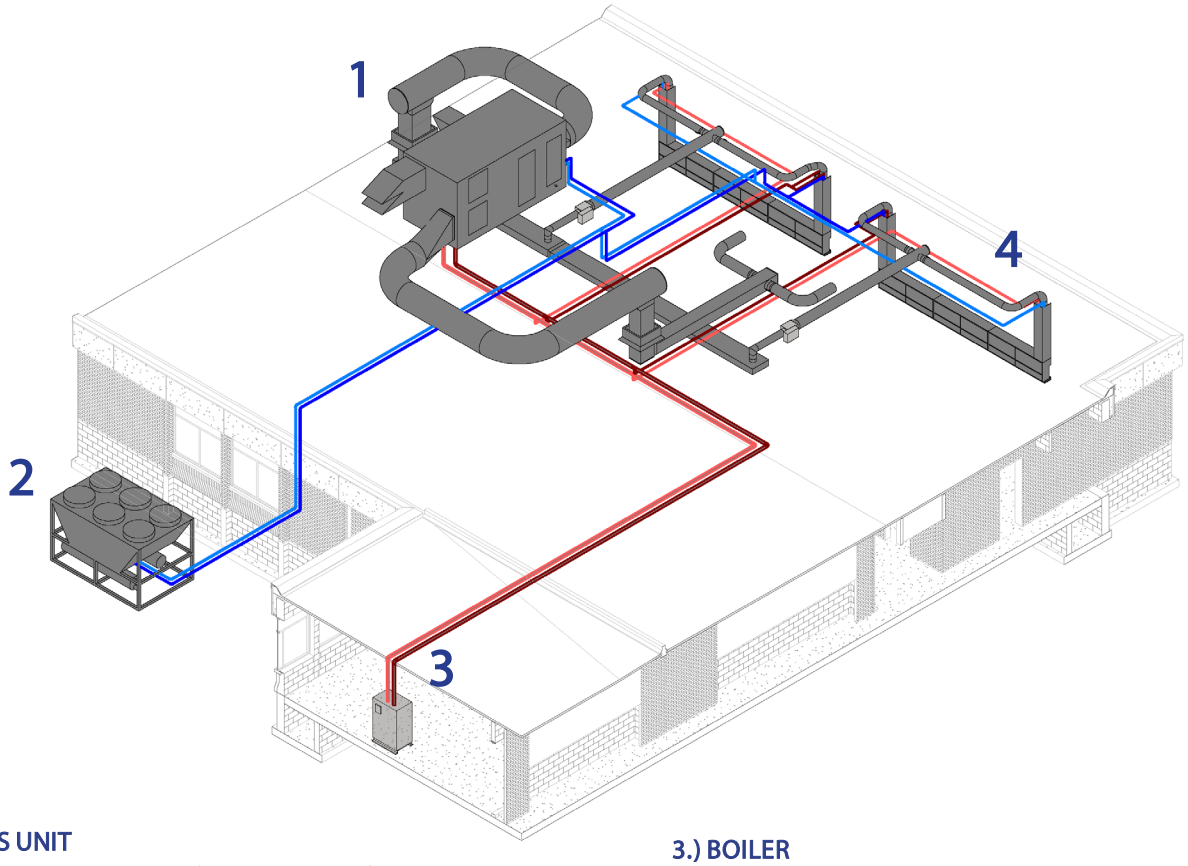
- **Dr. Yan Chen, Purdue University**
  ASHRAE Virtual Annual Conference in June 2021

TYPICAL APPLICATION SPACES FOR DISPLACMENT INDUCTION VENTILATION

The application of displacement induction ventilation is beneficial to a variety of K-12 environments, including classrooms, band/choir rooms, small offices, and dedicated learning spaces. Beyond those spaces in the K-12 market, the QLCI can be applied in higher education learning centers, dormitory rooms, healthcare environments, casinos, and any environment that needs improved indoor air quality.



TYPICAL HVAC COMPONENTS THAT DELIVER THE DISPLACEMENT INDUCTION OPERATION SYSTEM



1.) DOAS UNIT

- Provides 100% dehumidified outside air for code required ventilation needs
- Delivers verifiable outside air for occupants
- Rooftop or indoor mounting
- Shown with hot water or chilled water
    - Packaged DX and gas heat suitable
    - Geothermal suitable
- Typically, energy recovery based
    - Desiccant devices suitable
- Isolates rooms so no room-to-room airside cross contamination occurs

2.) CHILLER

- Provides chilled water for QLCI and possibly DOAS chilled water coil
- Air-cooled or water-cooled suitable

If DOAS unit is packaged DX, dedicated elevated chilled water to QLCI offers high efficiency option

- Alternatives:
    - No chiller design option (only HW available) packaged DX DOAS applied and design to deliver cool, dehumidified primary air for recognized sensible cooling in space
    - Geothermal water supplied

3.) BOILER

- Provides hot water for QLCI zone heating and possibly DOAS hot water coil
- Often high efficiency condensing style boilers applied
- Gas fired or electric boiler suitable
- Alternatives:
    - If existing steam source available; apply a steam-to-hot water conversion
    - Some climate designs may not require hot water in the zone
    - Geothermal water applied

4.) QLCI

- Receives 100% outside air from DOAS unit to drive room air induction process across integral coil
- Chilled water and hot water flow modulated to control sensible space loads
- Supply air delivered near floor in displacement mode for:
    - Effective removal of airborne contaminants for better IAQ
    - Low velocity, temperature air for enhanced thermal comfort
    - No moving parts to maintain, produce noise, or consume electricity
- Provides industry leading system efficiency due to displacement ventilation and fluid-based heat transfer

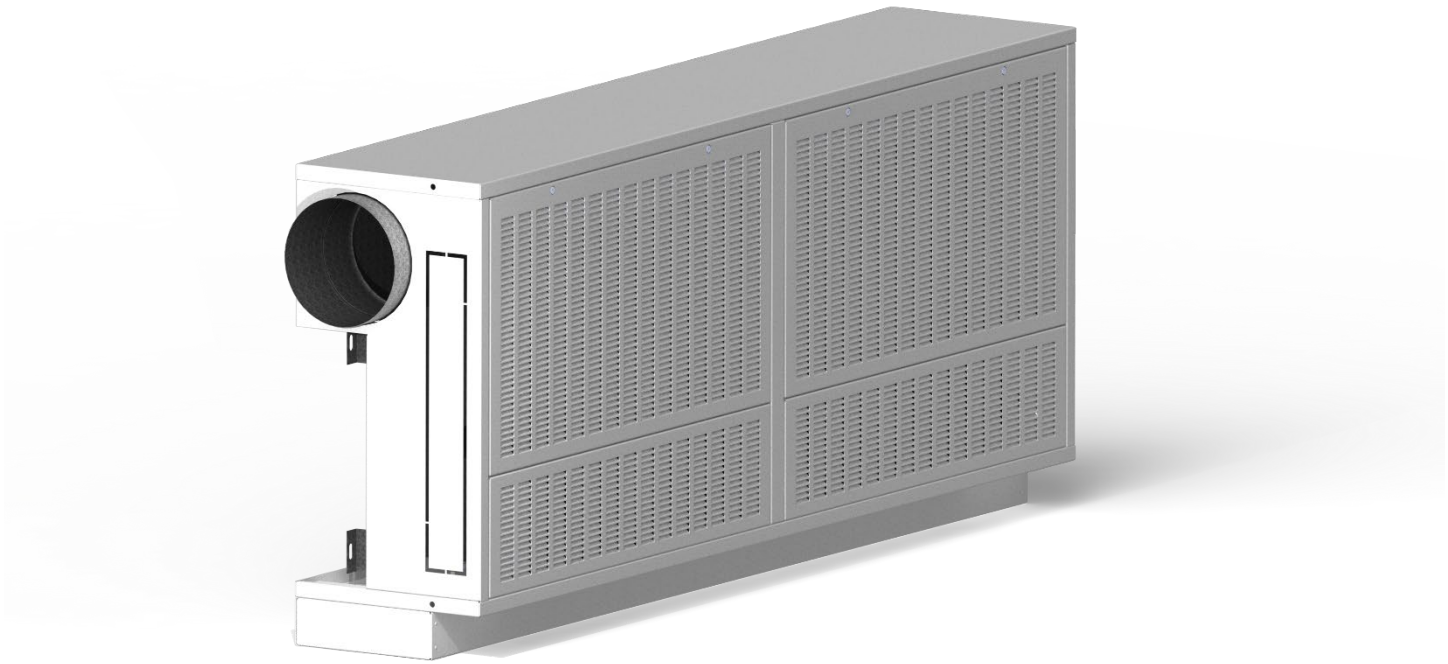
TYPICAL DESIGN CHALLENGS THIS VENTILATION STRATEGY ADDRESSES FOR CLASSROOMS

The QLCI meets the requirements for **RETROFIT AND NEW CONSTRUCTION** projects.

With more schools being renovated than new pop-up construction, let's review some of those more applicable items for retrofit applications:

- Aging infrastructure and rising maintenance costs
- Children are rough on classroom equipment
- Existing buildings have limited ceiling and mechanical room space
- Classroom floor and shelf space is valuable
- Classroom flexibility for the changing teaching approaches
- Heightened need for improved IAQ
- Proving required OA is delivered per ASHRAE standards
- Poor classroom acoustics
- Complicated systems control and maintenance
- Maintenance costs in declining school districts

Read the next sections for how this SYSTEM checks all the boxes for each of these outlined items for classroom spaces.



THE BENEFITS QLCI DISPLACEMENT INDUCTION VENTILATION STRATEGY DELIVERS FOR CLASSROOMS

IMPROVED, PROVEN INDOOR AIR QUALITY (IAQ)

After reviewing this Application Guide, the reader should understand displacement ventilation provides healthier air qualities as compared to mixed air systems. With the common metric of CO_2 levels in the space, the lower the CO_2 at room level means increased cognitive student activity which can be measured and is intrinsically the measure or Zone Air Distribution Effectiveness as outlined by ASHRAE and commonly referred to within the HVAC industry Ventilation Effectiveness, Ez. Recall from the Ventilation Building Block section and the comparison between Displacement Ventilation and Mixed Air Systems:

Zone air distribution effectiveness shall be calculated in accordance with the following equation:

$$E_z = (C_e - C_s)/(C - C_s)$$

E_z = zone air distribution effectiveness

C = average contaminant concentration at the breathing zone

C_e = average contaminant concentration at the exhaust

C_s = average contaminant concentration at the supply

With Ce and Cs being equal values, for example, common commercial space levels would assign 1000 ppm and 400 pm, respectively, the only way to attain an increased E_z value is to measure a lower contaminant level at the breathing zone, C.

Example: "perfectly" Mixed Air System: $E_Z = (1000 - 400)/(1000 - 400) = 1.0$ (default value in table 6-4, 62.1)

Example: "traditional" Displacement System: $E_Z = (1000 - 400)/(900 - 400) = 1.2$ (default value in table 6-4, 62.1)

Example: QLCI Displacement Induction System: $E_Z = (1000 - 400)/(860 - 400) = 1.3$ (tested, verified per 62.1 App C.)

As noted, the QLCI lab tested and CFD modeled data delivers a better indoor air quality than mixed air and traditional ventilation. In short, Ez, can be equated to "Contaminant Removal Effectiveness" and a direct measure of indoor air quality.

Note from ASHRAE 62.1-2019:

6.2.1.2 Zone Air Distribution Effectiveness. The zone air distribution effectiveness (E_z) shall be determined in accordance with Table 6-4 or Normative Appendix C.

Informative Notes:

1. For some configurations, the default value depends on space and supply air temperature.
2. Calculation of E_z using the procedures in Normative Appendix C may result in values greater than those listed in Table 6-4 for systems with the same description.

IMPORTANT: By these calculations and ASHRAE definitions, the QLCI displacement induction ventilation provides industry leading contaminant removal and high zone IAQ.

Purdue University lab tested and CFD modeled QLCI equipment through all modes of cooling and heating to prove the QLCI delivers stratified room conditions or displacement ventilation operation year round. See E_Z values for QLCI for cooling and heating modes on Page 8 of this Application Guide.

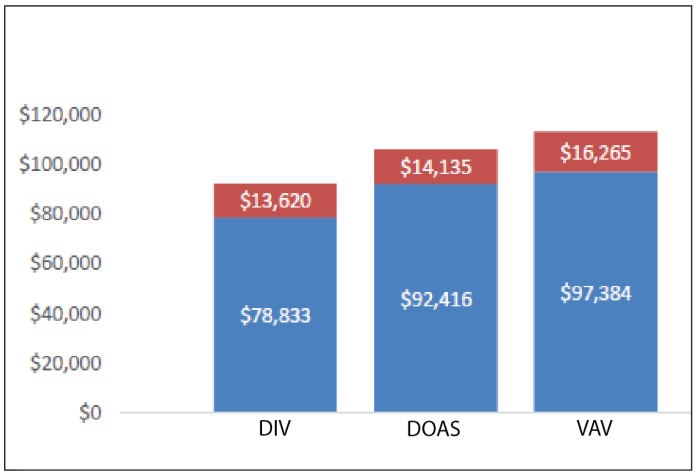
THE BENEFITS QLCI DISPLACEMENT INDUCTION VENTILATION STRATEGY DELIVERS FOR CLASSROOMS

DELIVERED, PROVEN INCREASED ENERGY EFFICIENCY

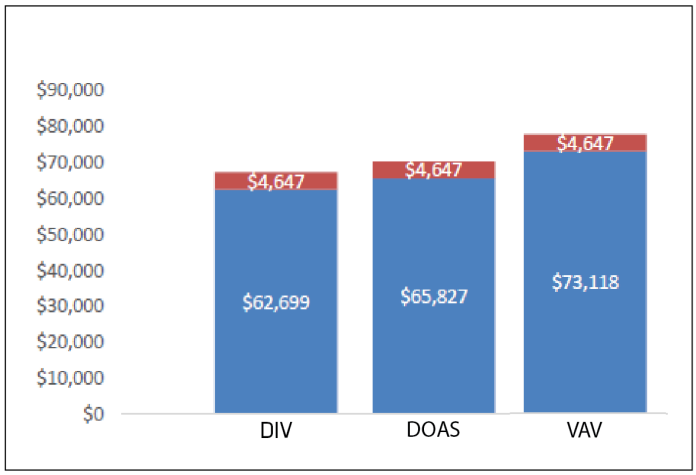
THE SAVINGS DELIVERED

DIV = DOAS-QLCI
DOAS = DOAS-FCU
VAV = AHU-VAV

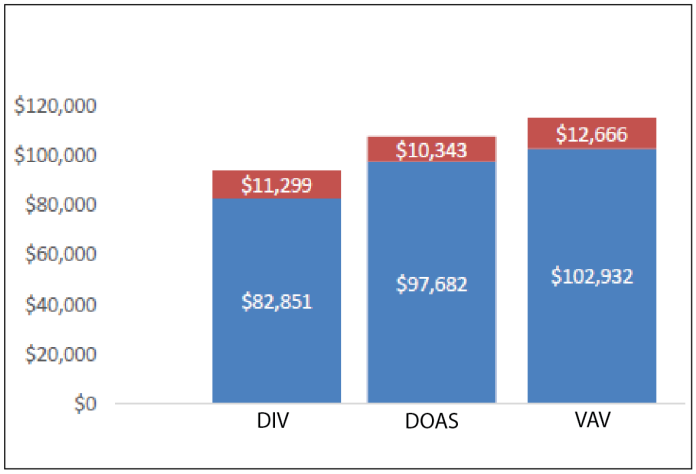
Minneapolis, Minnesota



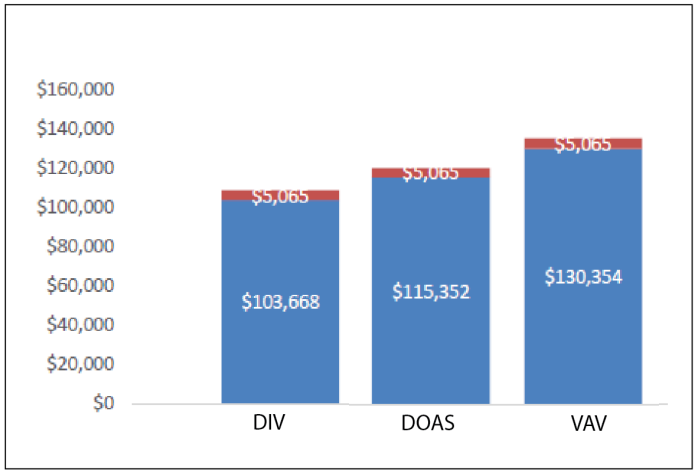
Seattle, Washington



Columbus, Ohio



Washington, D.C.



WHY DOAS-QLCI WINS

The results show a consistent and significant energy and energy cost savings for the entire building by simply changing the classroom wings to DOAS-QLCI in each of the locations studied – ranging between 15 and 25% savings compared to a VAV AHU system and 10 to 18% when compared to a DOAS FCU system.
The savings can be attributed to the following primary factors:

- Reduction in total ventilation required per ASHRAE 62.1-2019
- Greatly improved system efficiencies compared to current ASHRAE 90.1 benchmarks
- Reduction in chiller energy due to reduced airflow for ventilation and supply
- Increased chiller performance at part load due to primary and secondary chilled water loops with higher supply CHW temperatures to the DIV units
- Reduction in boiler energy due to reduced airflow for ventilation and supply
- Reduction in fan energy by eliminating FCU fans (DOAS FCU system)
- Reduction in total heating and cooling capacity related to reduction in peak outside air required

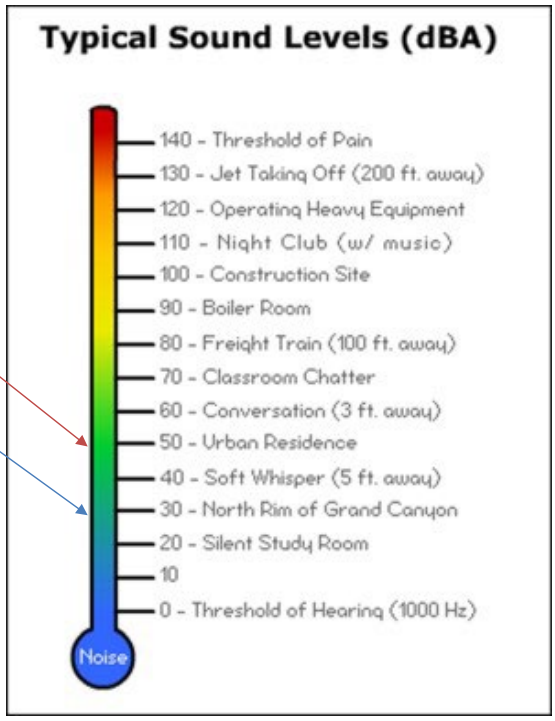
THE BENEFITS QLCI DISPLACEMENT INDUCTION VENTILATION STRATEGY DELIVERS FOR CLASSROOMS

LOWER, VERIFIED CLASSROOM ACOUSTICS

With no moving pieces and parts in the classroom, the QLCI operation delivers low sound levels, meeting ANSI 12.60 and LEED V4, for improved learning environments. Additionally, low supply air velocity into the spaces helps minimize velocity related sound compared to traditional HVAC terminal devices and diffusers.

When less acoustic distraction is present, the students are more attentive, the teacher's instruction is distracted thereby creating better learning environments resulting in better academic district performance.

- Onsite mockup at Minnesota Elementary School
- Mixed air system (unit ventilator):
  55 dBA NC50
- Displacement conditioning system:
  35 dBA **NC30**



THE BENEFITS QLCI DISPLACEMENT INDUCTION VENTILATION STRATEGY DELIVERS FOR CLASSROOMS

BETTER THERMAL COMFORT, AND INCREASE FLOOR SPACE UTILIZATION

QLCI Displacement Induction Ventilation delivers tremendous thermal comfort for occupants. With the full wall array, unidirectional airflow delivery, the supply outlet velocity is much lower than traditional unit vents, fan coils, or overhead diffusers. The combination of low velocity air and moderate supply temperatures eliminates any draft effects experienced occupant from those traditional HVAC terminal devices.

Increased thermal comfort levels:

- Minimizes learning distractions
- Eliminates the facility personnel disrupting learning periods for maintenance
- Eliminate NEAR ZONE or “draft” concerns and maximizes floor space for student spacing
- Meets thermal comfort requirements outlined in ASHRAE Standard 55

THE BENEFITS QLCI DISPLACEMENT INDUCTION VENTILATION STRATEGY DELIVERS FOR CLASSROOMS

DECREASED MAINTENANCE REQUIREMENTS FOR LESS CLASSROOM DISRUPTION & OPERATIONAL SAVINGS

The QLCI with no air moving devices in the classrooms as part of a decoupled or DAOS system helps address all those challenges.

No moving pieces and parts in classrooms mean low zone-based maintenance cost as well as providing less disruption to learning. The aspect of not having to go into the classroom for maintenance is key. The HVAC system, such as the DOAS unit, the chiller, and the boiler still has maintenance but the QCLI in the room has nearly zero requirements. There are no filters to change out, no dampers to adjust, no fans, motors, or compressors to repair or replace.

Once a year, typically during summer maintenance schedules, the facilities teams remove the front panel to expose the hydronic coil to inspect for small lint collection. A light vacuum procedure might be needed.

Why no filters? The low supply air velocity from the diffuser does not agitate the surface dust like other terminal units which higher velocities and so the duct collection is not at the level seen with other equipment.

No filtration required

- Low face velocities
- Dry coil surface
- Major expense saved on filter change out
- Easy to clean: vacuum coils 1-2 times annually

No blowers or motors

- Blower life expectancy 8-10 years
- No performance issues to deal with
- Cost of blower motor replacement and labor avoided

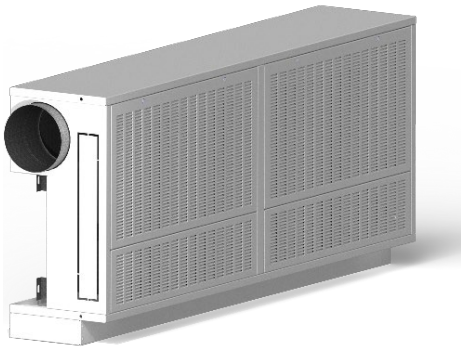
Low cost of ownership

- Significant energy savings
- Minimal maintenance and repair
- Less classroom down time

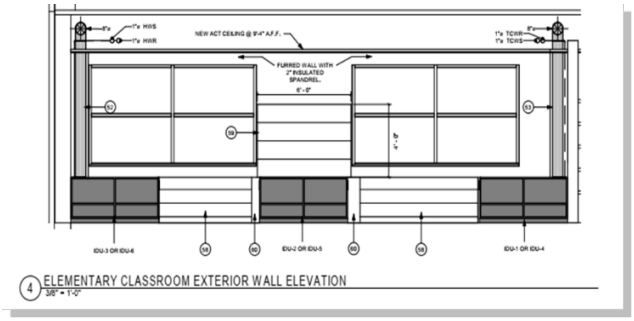
THE BENEFITS QLCI DISPLACEMENT INDUCTION VENTILATION STRATEGY DELIVERS FOR CLASSROOMS

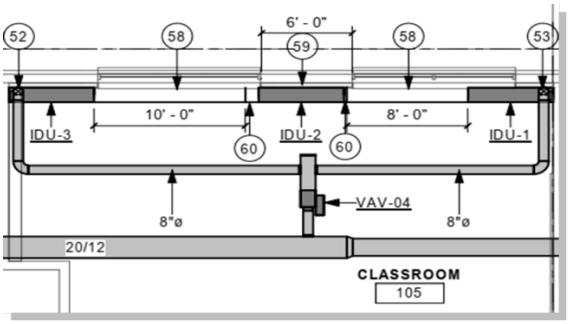
PUTTING THE PIECES TOGETHER FOR ARCHITECTURAL FIT, FINISH AND FUNCTIONALITY

- Rugged, heavy gauge constructed casing designed to withstand 250-pound point loads without deflection
- Durable, textured (matte finish) powder coat finish to withstand dings, nicks, and fingerprints
    - Carson Solutions offers an array of standard colors as well as optional custom colors should an owner or architectural requirement exist



- With a 1/3 the outside air being delivered to the space; downsized ductwork allows for ease of air transportation without impacting the existing low ceiling or tight plenum spaces. Or, perhaps for new construction applications, the small primary ductwork could afford the classroom a taller ceiling height than originally planned
    - Typical OA duct required for primary air to the classroom QLCI are 10" – 12" diameter

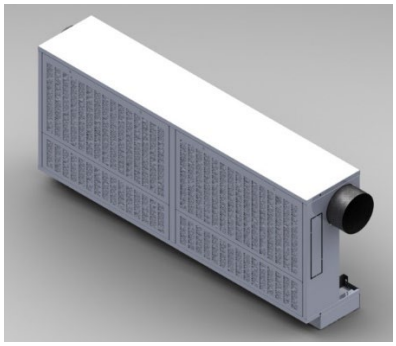




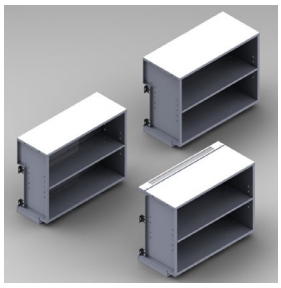
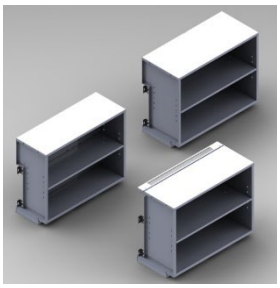
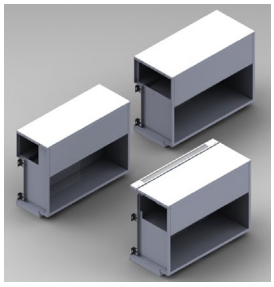
- Minimal floor space impact with the QLCI cabinet and with any consumed floor space, the QLCI provides an equivalent usable shelf space for books or other classroom needs – Shelf space is an inherent deliverable with the standard diffuser section
    - With the QLCI standard heating approach, there is no ventilation air out the top option ensures no conditioned air blocked by books
- Endless configuration possibilities to meet existing physical constraints such as column or windows. And at the same time, the wide array of classroom configuration options allows for designers to meet changing, flexible education environments
- If it's desired by the owner, architect, or engineer, not to have the QLCI footprint as part of the room layout, the QLCI and associated primary air ducts can be designed for RECESSED installation
- Two diffuser panel styles available
    - Louvered
    - Perforated
        - Perforated option is provided with internal components painted black

PUTTING THE PIECES TOGETHER FOR ARCHITECTURAL FIT, FINISH AND FUNCTIONALITY

TYPICAL ROOM LAYOUT CONFIGURATIONS



Start with the QLCI and add the other pieces to complete your puzzle.

To provide total Architectural and HVAC solution that delivers ventilation air, cooling, and heating in single architecturally pleasing array that fits as part of the furniture for room, staff, and students…

Before: Cinderblock walls, little natural lighting, noisy unit ventilators

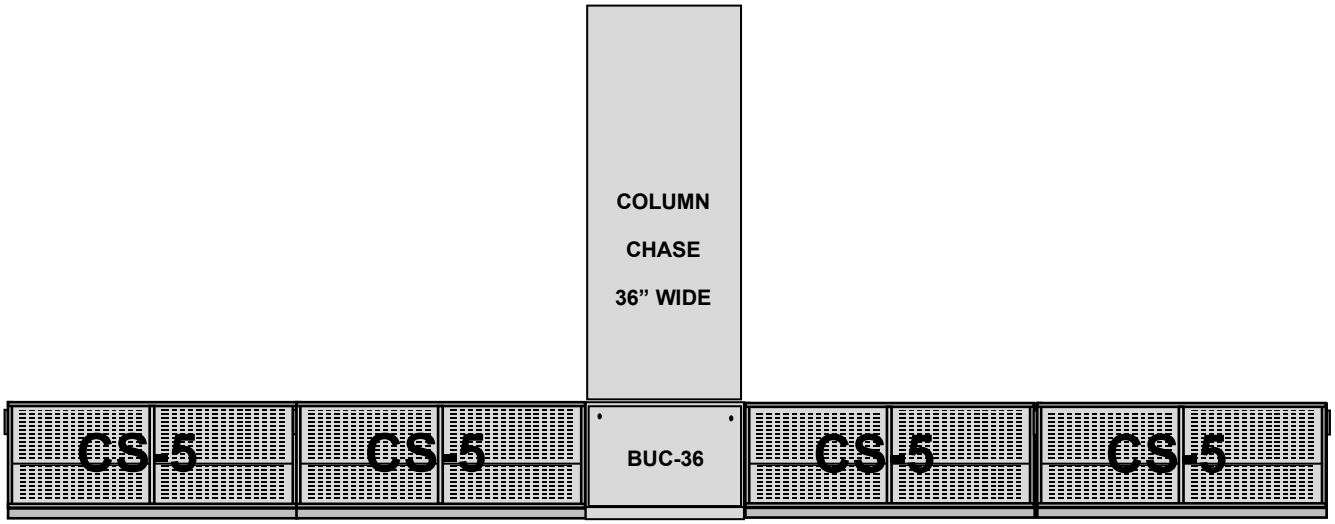
After: Tremdous amounts of natural lighting wholly integrated with th Carson Solutions QLCI and bookshelf assemblies

THE BENEFITS QLCI DISPLACEMENT INDUCTION VENTILATION STRATEGY DELIVERS FOR CLASSROOMS

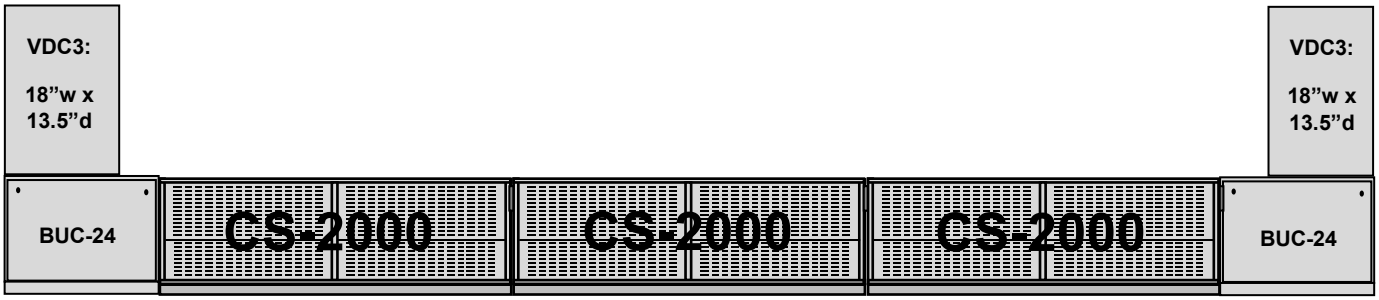
TYPICAL DIFFUSER AND ACCESSORY CONFIGURATIONS

Selected ROOM LAYOUT EXAMPLES:

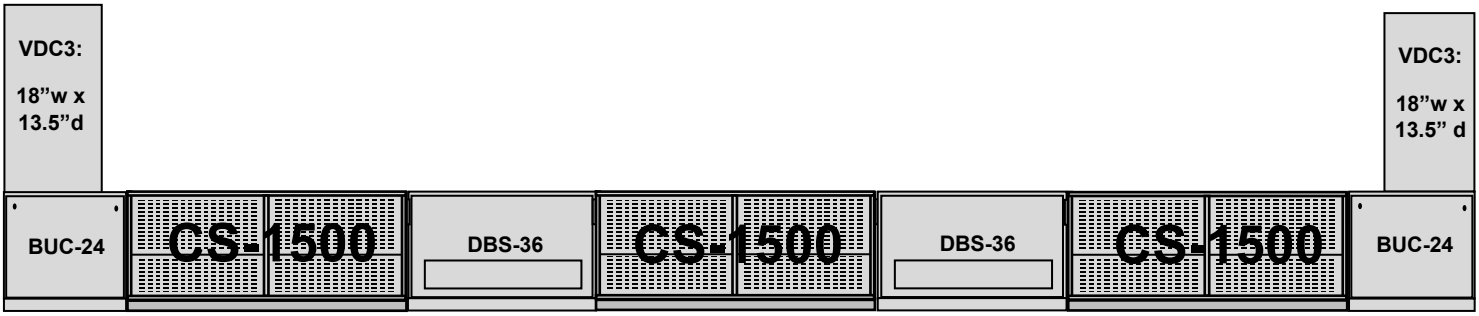
Four QLCIs, One VDCs center column chase, One BUC



Three QLCIs, Two VDCs, One BUC, Two DBS, Two BBS



Three QLCIs, Two VDCs, Two BUCs, Two DBS



For a specific QLCI and accessory configuration that meet the specific project requirements, please contact your local Carson Solutions' Representative or Carson Solutions directly.

THE BENEFITS QLCI DISPLACEMENT INDUCTION VENTILATION STRATEGY DELIVERS FOR CLASSROOMS

CUSTOM OFFERINGS TO COMPLETE THE ROOM

Carson Solutions offers a full array of custom sheetmetal offerings and configurations to mee almost any room layout for either a rennovation or new construction project.

Custom Bookshelves:

Often school districts are challenged with space constraints that don't allow for a full continuous array of components as shown previously. When needed, Carson Solutions can offer custom shelving to provide the needed shelving in a more compact design.

Laminate countertops:

For that finished furniture look, Carson Solutions offers laminate tops as an option for the various components. Laminate countertops provide a durable and affordable solution to create a polished look to your space. Choose from a wide variety of wear resistant shades in wood grain and solid colors.

Complete System Configuration Example:

Carson Solutions has the design and manufacturing capability to provide a full wall to wall assembly that provides your room ventilation, cooling, heating and storage for functionality year round.

Please refer to Carson Solutions' Accessories Brochure on our website for a more details on our custom options.