Impacts of COVID-19 on Restaurants:

Methods of Enhanced Ventilation and Air Exchanges

November 17,2020

I. Executive Summary

Our objective is to allow restaurants during the COVID-19 pandemic to maximize the utilization of outdoor seating during the winter months and to improve the safety of enclosed dining spaces when customers are not able to wear their face masks. Currently, New York City (the "City") and New York State regulations safeguard customers dining outdoors by requiring that the outdoor structures be partially open on one side to provide ventilation to reduce viral load. The government's solution, while effective to reduce viral load, unfortunately exposes the restaurants' customers to inclement cold weather, rain and snow while they dine in a difficult to heat outdoor space. This makes dining outdoors less desirable and therefore fewer customers will patronize the restaurants.

Our solution is to enclose these new outdoor spaces, but only in conjunction with an energy efficient increase in interior ventilation system to dilute and reduce the viral load that also directly exhausts the exhalations of each customer. The same principles can also be applied to interior spaces. We have provided a general overview of the problem focusing on the current situation in outdoor and indoor dining areas; and a detailed explanation of out proposed solution. If you agree with our assessment and calculations detailed below, we would like to discuss our design strategy as soon as possible. This strategy will permit restaurants to more safely use both their exterior and interior spaces at a higher occupancy level, with the goal of achieving 100% of their pre-COVID-19 occupancy while aiming for a reasonable cost and energy usage to achieve this.

II. General Overview

Sid Raman, one of the principals of RO Engineers and Architects, PC owned a restaurant in Jersey City and has first-hand knowledge of the many challenges of operating a restaurant.

Since the beginning of the pandemic, however, there has been one stubborn challenge to restaurant owners which has yet to be solved and to which Sid and his team would like to apply their unique experience as both a restaurant owner and as engineers. This challenge is the vulnerable situations where the COVID-19 virus can most easily be spread, as for example when a customer removes his or her mask while dining.

During the warmer months New York City's permission for outdoor seating has alleviated some of these problems. However, with winter setting in and New York City's requirement that outdoor structures must have one wall open to the outside environment to prevent a buildup of possibly contaminated air, the ability to make weathertight and heat such open spaces to provide customers a comfortable dining experience is a serious challenge.

This issue becomes even more urgent as cases of COVID-19 rise and restaurant owners see stricter restrictions or even possible closures looming. Closures of restaurants do not just impact the owner, but also their employees and an overall crucial sector of the economy of the City and residents at large. During surveys we did in preparing this proposal, the restaurant owner of the restaurant Pil Pil in the Upper East side said to us, “Restaurants are the heart of the City and if you kill them, you will kill the City as well”.

Recent CDC and ASHRAE guidelines for COVID-19 have focused on issues within spaces not equipped to handle the virus, such as restaurant interiors. The guidelines presented by these entities often mirror the systems and methods used in healthcare facilities. Two of these guidelines focus on increasing fresh air to spaces and increasing the overall number of air exchanges in an hour.

Providing increased outside-air ventilation rates dilutes the possibly infected air within a space. Properly increasing air exchanges and by exhausting possibly infectious exhalations directly to exterior locations reduces the time in which infectious particles remain in occupied areas. These two methods combined and properly implemented will minimize the possibility of an infected person not wearing a mask spreading the virus both in exterior and interior settings. In this proposal, RO Engineering presents two similar implementations for exterior and interior spaces, namely, increasing ventilation rates and air exchanges coupled with more direct exhausting of customers’ breathing.

A. Exterior Spaces

Our survey of some streets in the City show a myriad number of exterior seating structures that have been built. Some are simple plastic and canvas tent structures while other structures are more elaborate free-standing buildings complete with windows, interior partitions, etc. From talking with several restaurant owners, we have been told that customers generally prefer sitting in the outside seating area as it is perceived to be safer. However, winter weather conditions diminish the use of these areas to the point where restaurants are once again suffering economically.

No matter what type of exterior seating structure is used, the first step of our proposed design would be to enclose the fourth side, with City approvals, and to add some appropriate insulation to the structure to make it more weathertight and able to retain heat. This is a necessary step for occupant comfort and the use of these spaces during winter months.

The next step is to implement a strategy for increased ventilation and air exchanges within these now enclosed spaces, as well as more direct exhausting of the air exhaled by restaurant customers especially when not wearing a mask.

Using CDC and ASHRAE guidelines for certain healthcare facility space types, the airflow quantity chosen is based on ventilation rates and air changes per hour (ACH). Ventilation rates are the recommended outside air volumetric flow rates measured in CFM/person, and the recommended values are between 15-20 CFM/person is targeted in our design.

Similarly, ACH is based on the airflow quantity that can achieve a set number of air changes or the amount of times a volume of air is completely removed and replaced in one hour. The recommended value for ACH is between 6-12 with minimum of 3 air changes consisting of outside air.

The goal of this proposed design is to isolate each of the designated restaurant seating areas, grouped in seating tables of 4 to a maximum of 6 persons into individual "zones" to calculate the airflow in CFM required to achieve the recommended values of ventilation and air changes per hour. The assumptions to make these calculations and dividing the restaurant seating areas into "zones" are to implement a mechanical strategy to achieve increased ventilation and air exchange rates at these "zone" levels. Each table "zone" will have its' own floor-level directed air supply and above-table-height exhaust duct devices, both serviced, in our design, by a mechanical device known as an Energy Recovery Ventilator box. The proper placement of the intake end of the exhaust duct above the table is a key aspect of the design as it will help direct the table occupants' breath directly into the exhaust stream and not towards anyone else at the table or in the rest of the seating space of the restaurant.

The concept design will increase ventilation and air exchange rates at the designated "zones" while providing the more direct exhaust of the air exhaled by customers sitting within each "zone". This can be enhanced and supplemented with placing additional physical partitions and barriers, reworking the seating layout and combining with emerging CDC and ASHRAE guidelines to further decrease the chances of the virus from spreading from any infected customers to occupants at other tables or restaurant workers serving them.

B. Interior Spaces

Existing HVAC systems serving restaurants, when present, are not equipped with the means or methods to deal with the spread of COVID-19. Studies have shown that current ventilation and circulation of air in most interior designs can increase the likelihood that many occupants can come in contact with the virus since virus bearing air pathways can be created from infectious persons to other tables as the air travels from numerous air supply points to one or more remote exhaust locations, often located in bathrooms or through kitchen exhaust systems. When any person is downstream of an infected person in such an airflow situation, the chances of being infected are considerable, especially vulnerable when a mask is not worn as is the case when eating or drinking.

As discussed below, our strategy for interior spaces is the same as for exterior spaces above, using the individual "zone" concept, but involves more site-specific issues which need to be considered for locating the mechanical equipment and for routing supply and exhaust ducts.

III. Details of the Proposed Strategy for Exterior/Interior Ventilation

The equipment chosen to achieve the designed airflow rates, calculated using methods described above, is either an Energy Recovery Ventilator (ERV) or a Heat Recovery Ventilator (HRV). The ERV will recover more energy but is also more expensive. Where power for supplemental heat is an issue, an ERV may prove to be advantageous. For the remainder of this discussion, we will use ERV as the chosen device. An ERV utilizes fans and a core to have two airstreams cross and exchange energy. Outside air is provided from the exterior to the interior as one airstream and return air from the space is exhausted to the exterior as the second airstream. During colder months, the outside airstream crosses the heated air from the interior and transfers heat to increase the temperature of the fresh air provided. As the fresh air will only be tempered by the exchange in heat, supplemental heat is needed. This is an energy efficient method to provide increased quantities of ventilation air while also exhausting the same quantity of air from the interior, maintaining a neutral or balanced pressure. Additional information regarding the use of Energy Recovery Ventilator's in response to COVID-19 can be found in Renewaire's, the ERV manufacturer for equipment model chosen in this design, white paper discussion #LIT_152. We designed this strategy for two theoretical spaces, one being an interior restaurant space in Jersey City and the other being an exterior seating area in the Upper East side of Manhattan. One important note for the exterior space is that, as mentioned earlier, NYC DOB requires one side of an exterior structure to be open to the outdoors. Since supplemental heat is needed in the winter, there is a large loss of energy through the one side that is open. The concept design presented for the outside seating area could allow for all sides to be enclosed, allowing for people to pass through of course, so the energy added to the space is not completely lost.

For this discussion we present the use of one ERV for each table of 4 to 6 people. In theory if the system is air-balanced between the supply and return, cross contamination of the supply and exhaust air would not occur in the ERV box in any tangible amount, but this is not a straightforward situation for the various field conditions that could be encountered.

By limiting our discussion to the use of one ERV to just one table of 4 to 6 people, if a system is not balanced, any cross contamination is localized only to the party of people sitting together at that table. However, and most importantly, with the effects of the ERV filtration and dilution due to enhanced outside-air ventilation, any such contamination is far diminished than the alternate of not having this design in operation. With one ERV and supply and exhaust serving one "zone" exclusively, the possibility of cross-contamination from one table to another will be diminished to non-existent. This design will still require the presently established practice of restaurant customer putting on their masks when not sitting at the table.

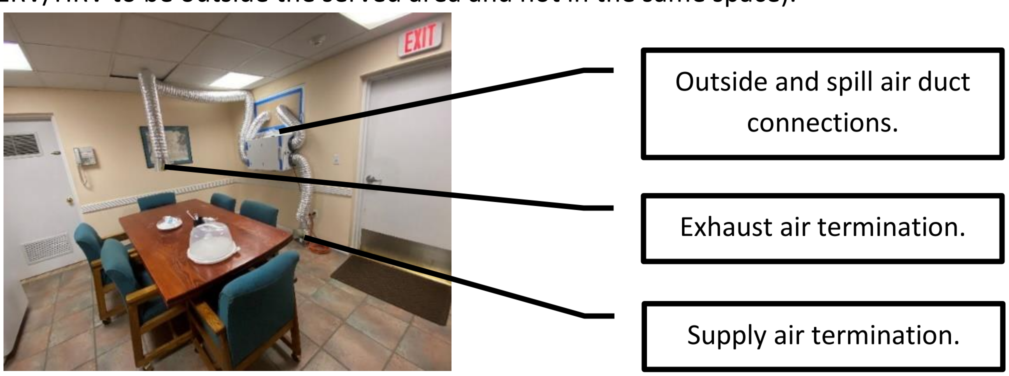
We do want to note that when properly used per manufacturer's specifications and with added engineering design and controls, one larger sized ERV or HRV can operate to serve more than one table "zone". This would still require exhaust ducts to be located over each table and distributed supply ducts as well. This will probably reduce the costs overall but is an engineered solution for ducting and balancing which will be site specific.

Creating such isolated table "zones" with increased ventilation and air exchanges achieved with the design shown, should greatly reduce the chance of infectious particles migrating to adjacent tables and provides the recommended levels of ventilation and ACH at each "zone". With these strategies implemented in the various restaurant seating areas, the overall chances of the COVID-19 virus spreading can be decreased. If this strategy is permitted to be used by the governing bodies, then it would allow restaurants to increase capacity at interior and exterior seating areas while providing an energy efficient means to benefit the customers.

A. Pictures of ERV Layout and Testing

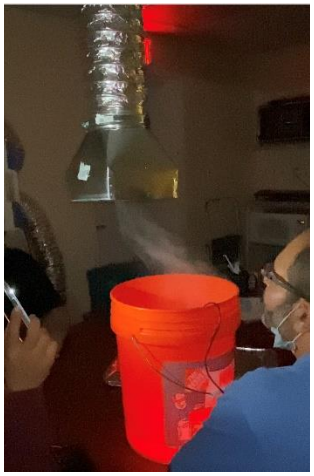
We assembled and used the prototype system in our office lunch-room space in Belleville, NJ. We employed an ERV which we fitted with the stock MERV 8 filter (In theory, a higher filtration MERV 13 filter would be able to filter out some of the viral load on the supply side). A MERV 13 filter, our calculations indicate, would still provide adequate ACH for a 4-person setup as per the guidelines mentioned. (Note that we placed the ERV within this room only to prototype the system, we do not recommend this placement. We recommend instead that the ERV be in a weatherproof enclosure outside of the occupied area to minimize noise and any incidental air leaks from the ducts.)

1. Example ERV layout in lunchroom of an office (Note: This is a prototype, we recommend the ERV/HRV to be outside the served area and not in the same space).



2. Testing showing path of fogged air to exhaust termination (left to right) - the bucket contained a source of water mist that was used to show the zone where the suction of the exhaust is active.

3. Snippet of video which conveys how a person speaking would have his breath carried in the direction of the exhaust termination - the bucket supplies a source of mist which was propelled by the person's breath and suction towards the exhaust duct.

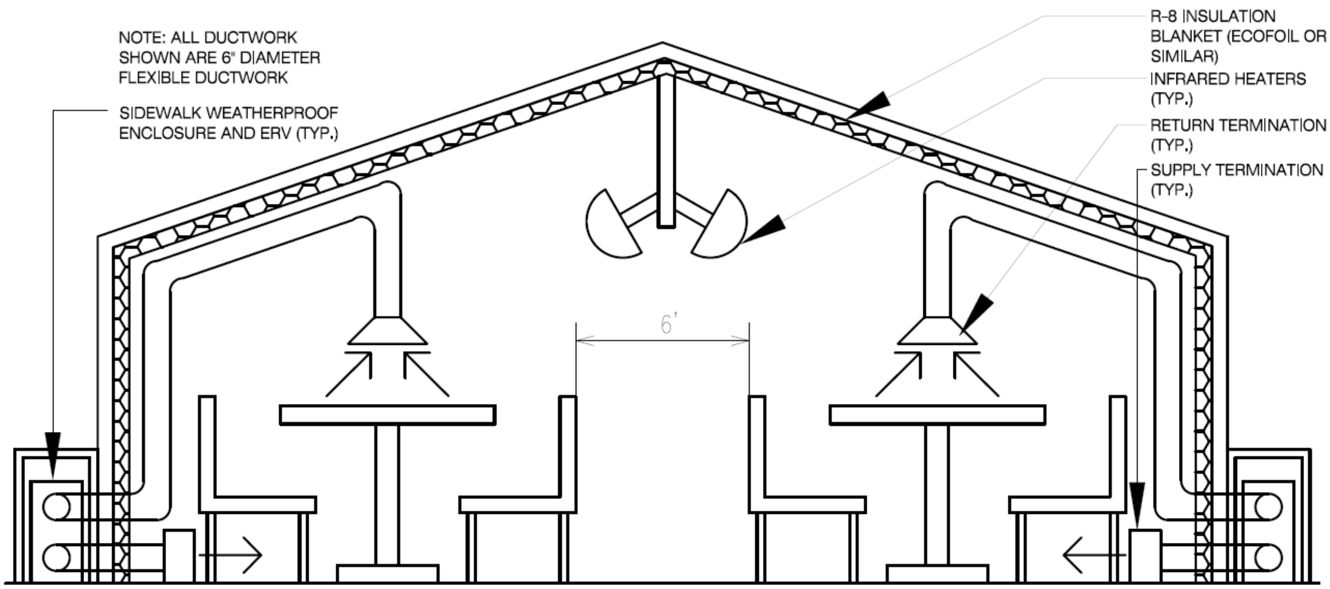


4. Examples of exterior Seating Structures and Arrangements.

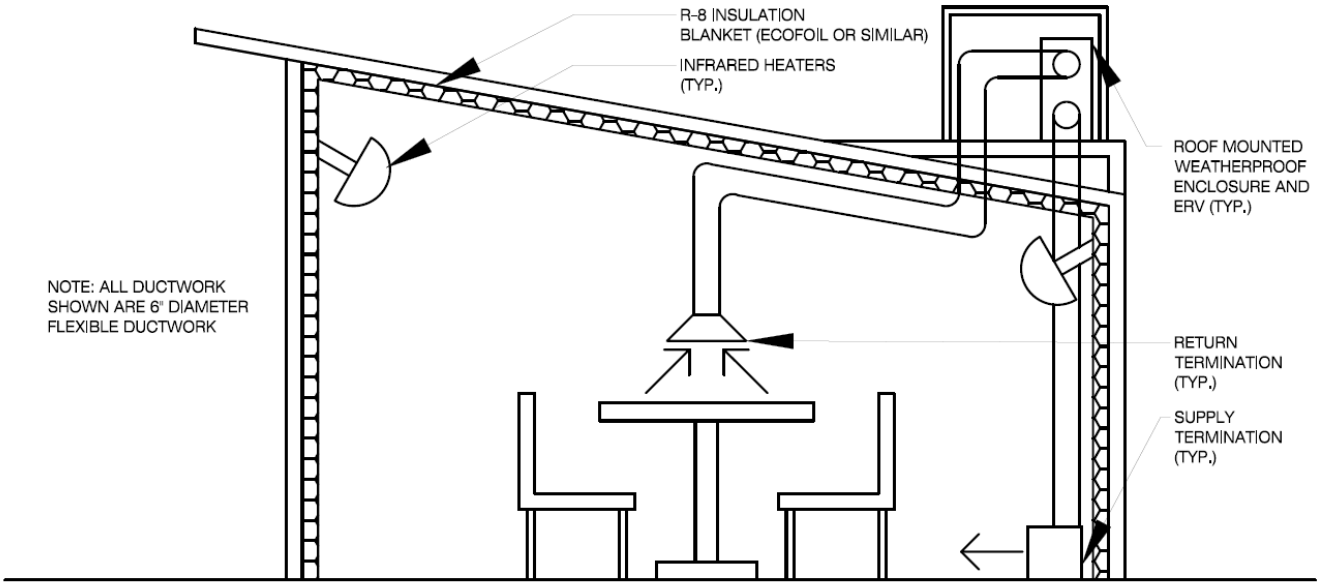
As can be seen in these pictures a variety of structures have been built, but all of them are open to the elements while attempting some heating device within the spaces.

*Picture in top left corner is the structure in front of the restaurant Pil Pil.

5. Section of Example Outdoor Seating Area Equipment Layout for a Tent Like Structure - ERV can be mounted in any convenient orientation.



6. Section of Example Outdoor Seating Area Equipment Layout for a Built Structure - ERV can be mounted in any convenient orientation.



B. Cost Considerations

Any proposed solution should be economically feasible and to that end we have made a cost estimate of this proposed strategy "by chair served" for the owner to determine whether this is reasonable.

Exterior space application <u>at each table of 4 to 6 chairs.</u>

a. Cost of ERV installed - $ 1,000 (RenewAire EV130 used for pricing)
b. 6-inch Flex Ducts and outdoor weathertight enclosure - $ 500
c. Electric Power (allowance for each location installed) $ 500
d. Insulation (area conservatively assumed at 400 sq. ft per table) $ 400

Total estimated cost per table of 4 chairs - $ 2,400 or $ 600 /chair

Used for at least 6 months (this winter) or 120 days, this works out to:

$ 600/120 = $ 5/day/ chair serviced by the system.

This cost calculation was presented to several restaurant owners, including the owner of Pil Pil who stated that this was very reasonable. Even doubling this estimate to $ 10 per seat in some tougher installs or power requirements, this cost could be passed on to the customer, he felt.

These costs do not include the cost of tent/structure that already exist, and the cost invested in supplemental heating units which we saw was already in many of the temporary locations.

Electric Power requirements are a consideration and since at many locations throughout the City, restaurants tend to be clustered together, the use of temporary generator truck of a higher capacity by a group of owners could be the most cost-effective way to provide the necessary power for supplemental heating and to power up these units. The units themselves only require less than 100 watts each to run. So, to serve, for example, 16 seats at <u>each</u> of the Pil Pil restaurant structures shown in the photo above, would need about 0.4 kw of added power for the ERVs. However, for the size of <u>each</u> of the Pil Pil structures with the added R-8 insulation shown in the concept drawing, about 3 kw of supplemental heating load would be needed.

IV. Conclusion

We would like for you to consider the above proposal to preserve economic viability of restaurants in difficult months ahead while ensuring a greater degree of safety to restaurant customers and employees utilizing the strategies described herein. With your help and feedback this strategy can be implemented to allow restaurants to more safely operate in both exterior and interior spaces at pre-COVID-19 occupancy levels in a safer setting utilizing a cost and energy efficient design.

Collaborators:

We would like to give a special thanks to Valerie Corbett, LEED AP BD&C, MFBA (President) and Allen Hobbs, Esq., MFBA (Senior Vice President and Counsel) at Intelligreen Partners, LLC who collaborated in discussions and helped edit this proposal and design. They also provided introductions to several restaurant owners whose properties we surveyed for this report.

The RO Engineering team that has prepared the above proposal and design are Sid Raman, PE, LEED AP (President), Umesh Gadre, PE, CEM (Mechanical Engineer), and Jake Burns, EIT (Mechanical Engineer).