Retail Ventilation System Redesign

The mechanical system redesign will consist of two parts. The first part of the system redesign will incorporate changes in the retail section's ventilation system. As discussed in the previous section of this report, the current ventilation system does not come close to meeting the requirements set forth in ASHRAE Standard 62.1-2007. For this reason the ventilation system redesign is being considered an essential change to ensure proper building conditions; therefore, the additional cost associated with the additional duct work will not be included in the overall mechanical system redesign costs discussed in the next section of this report.

Ventilation System Redesign Objectives

The foremost objective of the ventilation system redesign is to ensure proper ventilation to the occupants breathing level. The current system configuration is over ventilating the third floor of the atrium which has the smallest floor area of all the floors, while the second and first floor are severely under ventilated. These floors are under ventilated at times by ten times less than prescribed in ASHRAE Standard 62.1. The design is intended to allow the over ventilated air to flow from the third floor to the lower levels; however, the problem of short circuiting is a serious concern due to the returns for four air handling units being placed just a few feet from the supply air on the third floor. To handle this situation all new supply ductwork was laid out to directly ventilate all spaces that require ventilation as prescribed by Standard 62.1. Similarly, the large return air plenums found on the ceiling of the third floor will be replaced with return air ductwork that will ensure proper air travel and to eliminate any short circuiting. While more duct work will have a large impact on the cost of the ventilation system, it will untimely increase the efficiency of the system and ensure proper ventilation to all spaces.

The second objective eliminates the naturally ventilated spaces on the ground floor. The proximity of the parking garage and loading dock to these spaces caused a concern and in fact did not comply with the natural ventilation standards. The redesign will use an existing duct riser from RTU-2 to supply the previously naturally ventilated spaces with a forced air system.

Ventilation System Redesign Results

To redesign the ventilation system the results of the building load calculations obtained from TRACE 700 were used. The maximum supply air to a space was designed based on either the thermal load demand or the required outdoor air found from Technical Report One. Both were used to ensure that the correct amount of air was being supplied. The ventilation calculations can be found in Appendix B of this report, and the load calculations will be discussed in greater detail in the next section of this report. The dimensions of the supply ductwork were selected based on a value of 0.06 inches of static pressure per hundred feet of supply air ductwork. The dimensions of the return ductwork were selected based on a value of 0.08 inches of static pressure per hundred feet of return air ductwork. Plenum space was also taken into consideration when sizing the ductwork. In all cases the existing plenum space did not need to be altered to accommodate the new ductwork.

Before the layout of the new ductwork was chosen, a computational fluid dynamic model was created to track the particle distribution on the existing and the proposed ventilation system. Both models were created using the same geometry file as well as the same meshing conditions to ensure accurate comparisons. The major change between the two models are the boundary conditions. The existing boundary conditions were taken from the existing drawings. These conditions include diffuser locations on each floor, the velocity of air supplied from the diffuser, the temperature of supply air, and the location of the high return plenums. The proposed redesign also models the same conditions as the existing but includes the new diffuser locations, supply air velocity, and the localized return air grilles. Figure 13 below shows a side by side dye trace comparison of the two models during winter heating conditions.

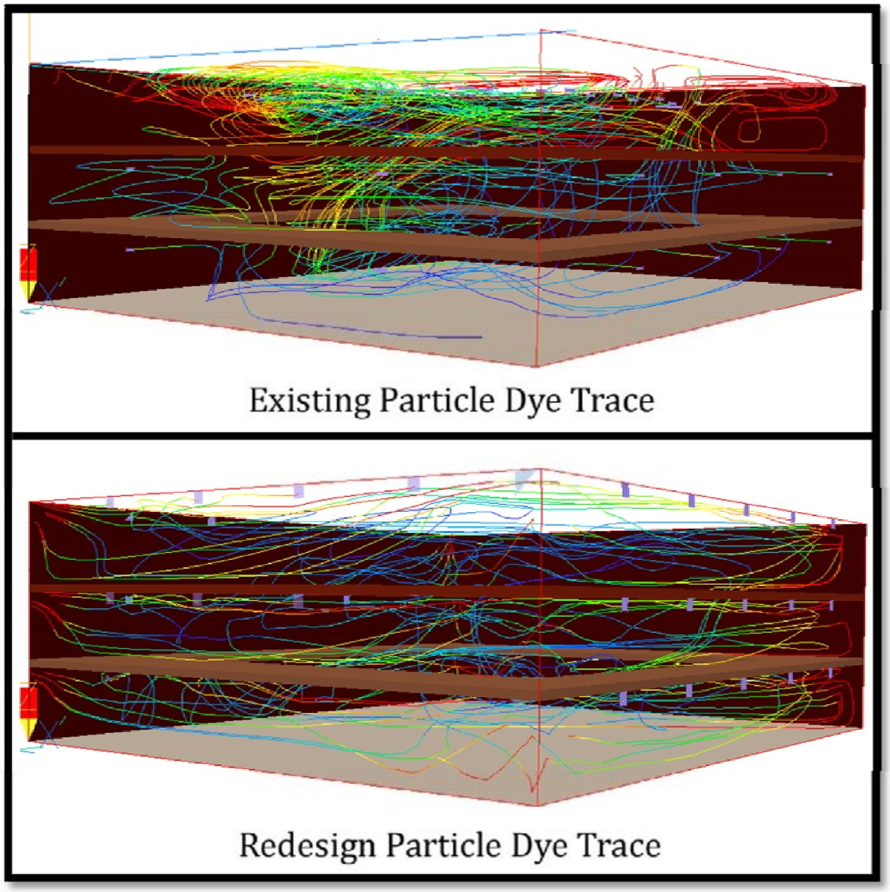

Figure 13: Computational Fluid Dynamics Particle Trace Model

The above CFD model images show the winter heating conditions present in the retail sections atrium. A summer cooling model was also run; however, due to the buoyancy effect of air, the cool supply air dropped to the lower floors and did not present much of a short circuiting problem. However, the winter case shown has a significant short circuiting problem. The warm supply air tends to linger at the top of the atrium and is quickly pulled back through to the return air system. This is evident by the large amount of dye traced particles on the third level of the existing conditions. These particles never make it to the lower level which is represented by the lack of traced particles on the first floor. The opposite can be seen for the redesign. The redesign has a much better overall distribution of particles. This allows the system to deliver the proper amount of ventilation to the spaces and increases the overall system efficiency. Based on ASHRAE Standard 62.1 and the results from the CFD study the ventilation system layout was used.

To incorporate the forced air system to the ground floor an existing ductwork riser serving RTU-2 was extended to the ground floor. Through this riser the supply air and return air ductwork can be routed to the ground floor, eliminating the concern of vehicle exhaust contaminants entering the building via the existing natural ventilation louvers. To ensure proper duct placement the use of three dimensional modeling was implemented. A sample image of the model used to redesign the ventilation system can be seen in Figure 14 below.

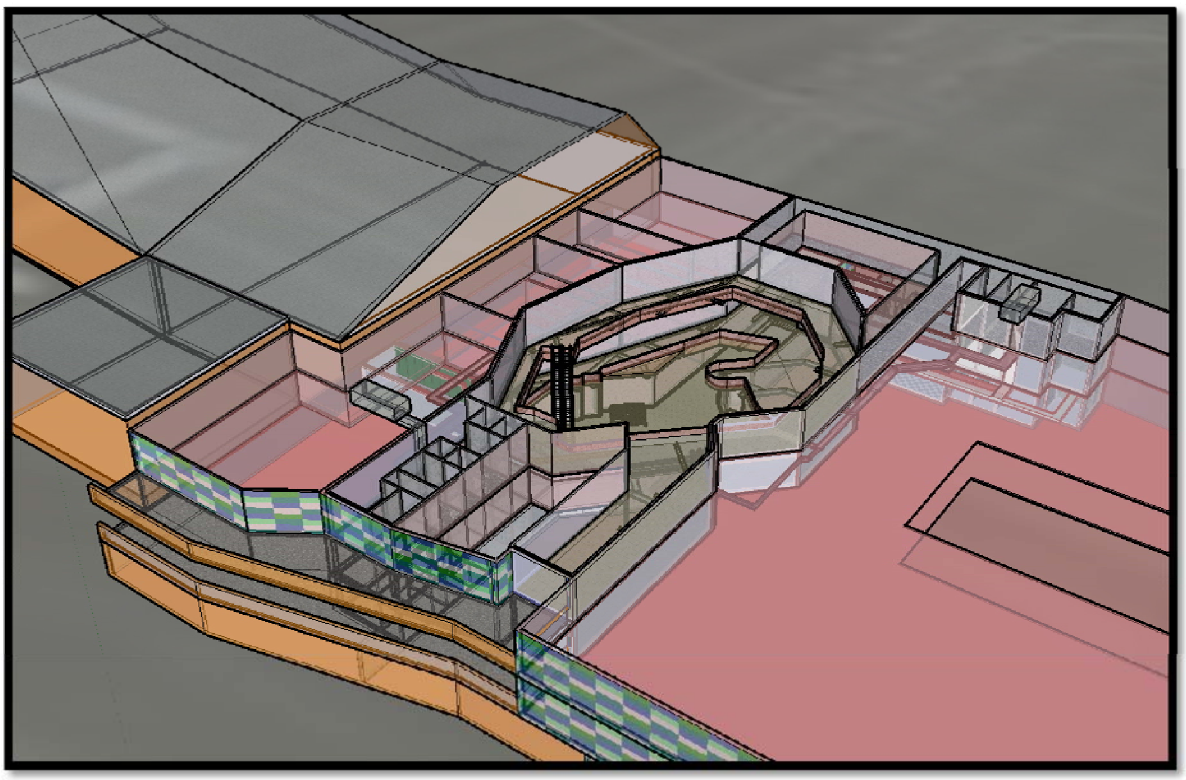

Figure 14: Ventilation System Layout Model Image

Ventilation System Redesign Summary

The redesigned ventilation system provides a better air distribution than the existing conditions as shown through ASHRAE 62.1 calculations and the use of computational fluid dynamics. While the overall effectiveness of the system is greater, the redesign introduces nearly 17,100 pounds of new sheet metal for ductwork. The new ductwork nearly doubles the price of the retail ventilation system; however, the increase in price can be seen as minimal to ensure proper ventilation. Spaces that are not properly ventilated can cause many types of indoor air quality problems which can be problematic and expensive to fix after the initial construction is finished. For these reasons the redesign of the retail ventilation system to meet compliance with ASHRAE Standard 62.1 is a practical if not necessary step in the mechanical system redesign.

Ventilation System Comparison Summary			
Item	**Existing System**	**Redesign System**	**Difference**
Total Length Supply Duct (ft)	2,423	3,450	**1,027**
Total Length Return Duct (ft)	0	2,294	**2,294**
Total Weight of Ductwork (lbs)	23,612	40,661	**17,049**
Total Cost	$1,013,193	$2,077,902	**$1,064,709**