SUMMARY

This dissertation investigates the airflow and pollutant distribution patterns in a simulated "negative pressure" isolation room by means of site measurement and CFD modeling. Site measurement was carried out using tracer gas technique to simulate the infectious pathogen exhaled by the patient.

A 3D model was constructed using Gambit modeling software and Fluent V5.5 solver software to simulate the actual experimental set-up. The CFD modeling results were validated with the site measurement results and it has shown to be capable to predict airflow and pollutant distribution patterns with an acceptable level of accuracy.

To study the effect of different diffuser layout and air change rate on pollutant concentration, pollutant removal efficiency (PRE) and air velocity, six models with 3 different layouts were modeled with different air change rates using the same simulation parameters and boundary conditions of the base model. In Layout 1, the supply air diffusers and exhaust air grilles are located at the ceiling to simulate the actual experimental set-up, with all the furniture removed. In Layout 2, the two exhaust air grilles are relocated to the wall behind the bed at 0.3m above the floor. Layout 3 replaced the ceiling diffusers with supply air grilles to provide a direct throw of air to the room.

The simulated results show that low-level exhaust as in Layouts 2 and 3 is very effective in removing pollutant at human breathing zone compared to ceiling exhaust. Layout 3 is observed to have the best arrangement for removal of pollutant as the supply air grilles provide a direct throw of cold air into the room to minimize mixing.
of supply air with the room air to prevent re-circulating, trapping and build-up of pollutant in the room.

The study also observed that the pollutant concentration decreases with an increase in air change rate. For Layouts 2 and 3, it is observed that PRE increases with the decrease in the air change rate. The high velocity air jet under the bottom door gap creates an eddy current in the room and increases the mixing of room air with the supply air. The pollutant distribution pattern is observed to be highly dependent on the velocity flow field.

It is observed that the furniture layout has an impact on the airflow and pollutant distribution patterns in the isolation room. With proper design of room furniture and arrangement of patient bed (pollutant source), it could help to channel the infectious pathogen exhaled by the patient directly to the exhaust without dispersing to the health-care workers.

The air velocity at all the sampling points of the models is observed to be less than 0.25 m/s and is within the acceptable limit by ASHRAE Standard 55 (1992).

Design strategies for “negative pressure” isolation room are recommended based on the observations made on the airflow and pollutant studies in the CFD simulation and the experiment conducted.