ABSTRACT
Lim, Soojung Ph.D., Purdue University, February 2010. MODELING AND DESIGN OF A ULTRAVIOLET DISINFECTION REACTOR FOR AIR RECIRCULATION SYSTEMS BY COMPUTATIONAL FLUID DYNAMICS. Major Professor: Ernest R. Blatchley III.

It is well established that many pathogenic microorganisms can reside in water. Similarly, many microbial pathogens can be suspended in air. However, disinfection processes for air are generally not as well developed as those for water. In situations involving groups of people in confined space, such as class rooms, surgery rooms, and airplane cabins, a shared air space provides opportunities for disease transmission. To reduce the danger of infections transmitted from one person to another, the addition of UV treatment in an air recirculation system may be employed. With this in mind, the primary goal of this research was to evaluate and develop an effective UV disinfection system for an air recirculation system. The specific focus will be an aircraft cabin air; however, it is expected that the principles that govern the design of this system will extend to other applications. This objective was met by first developing biodosimetry for evaluating reactor efficiency. A second step in the process of developing this system was to examine various reactor/systems by numerical modeling.

Laboratory experiments involved measurements of UV dose-response behavior for several airborne microorganisms. These experiments involved a range of non-pathogenic microorganisms as surrogates for airborne microbial pathogens; *Bacillus subtilis* spores and coliphage MS2. These microorganisms were grown in pure cultures, and were selected to mimic the range of characteristics that represent airborne pathogens in confined space. UV dose-response behavior of these microorganisms was measured as a function of relative humidity.

Various reactor geometries were evaluated by a process of numerical prototyping, which involved the combined application of computational fluid dynamics (CFD) and radiation intensity (I) field models. The effects of UV-based treatment on microbial air quality were also examined mathematically. The objective of this modeling effort was to develop a reactor system that satisfies the constraints imposed by an aircraft cabin environment.

The feasible reactor system for aircraft cabin recirculation system was designed in this effort, based on the power and space requirements needed to deliver germicidal UV doses that are likely to be effective for control of airborne pathogenic microorganisms. Designed reactors may be used in other applications for air recirculation system.