**PROJECT TITLE: Modelling polycyclic aromatic hydrocarbon (PAH) emissions from aircraft surrounding MSP**

**I. PROJECT STATEMENT**

Pollution from aircraft adversely effects human health by increasing mortality rates, exacerbating respiratory problems for at risk populations such as the young and elderly, and possibly accelerating degenerative diseases like Alzheimer's and Parkinson's. Minnesota generally has good air quality but there is no “zero threshold” for health effects; for example, adverse health effects from carbon monoxide (CO) exposure occur at levels far below the existing EPA mandates. Of particular importance is polycyclic aromatic hydrocarbons or PAHs. Human exposure to PAHs is linked with cancer, cardiovascular disease, and poor fetal development. The MSP airport operates thousands of commercial aircraft flights daily, with typical take-off flight paths cutting through South Minneapolis, Edina, and Richfield neighborhoods, resulting in increased levels of noise and exhaust pollution for residents. While noise pollution mitigation techniques have been enacted in these neighborhoods, air pollution is more difficult to address. The Minnesota Pollution Control Agency (MPCA) currently operates 26 air quality monitoring sites in the metropolitan area but there is *only one within approximately 10 miles of the MSP airport.* Determining spatially and temporally resolved air quality is difficult due to the relatively high cost of a single instrument that can accurately measure these pollutants so that measuring the effects of aircraft traffic on local air quality is not possible with current tools. The best solution for moving forward in understanding the magnitude of the problem is to model the emissions with software.

**We seek to use commercially available software to model emissions of polycyclic aromatic hydrocarbons (PAH) and other air toxic gases from aircraft in areas surrounding MSP.** This work will leverage government (FAA) developed, commercially available software called *Aviation Environmental Design Tool (AEDT)*. In brief, “AEDT is a software system that dynamically models aircraft performance in space and time to produce fuel burn, emissions and noise. Full flight gate-to-gate analyses are possible for study sizes ranging from a single flight at an airport to scenarios at the regional, national, and global levels. AEDT is currently used by the U.S. government to consider the interdependencies between aircraft-related fuel burn, noise and emissions”.1 Specifically we will focus on the following compounds that consist of PAHs and other important air toxics or hazardous air pollutants (HAPs): 1,2,3; 1,2,4; 1,3,5-trimethylbenzene,1,3-butadiene, 1-methyl naphthalene, 2-methyl-naphthalene, acetaldehyde, benzaldehyde, benzene, dimethylnapthalenes, ethylbenzene, formaldehyde, isopropylbenzene, naphthalene. These represent some of the most hazardous gas phase emissions from aircraft and approximately 22% of their total volatile organic carbon (VOC) gas phase emissions. The primary outcome of this work is accurate, temporally and spatially resolved, air quality model results that will allow stakeholders to make informed decisions about aircraft flight patterns and housing choices that preserve, protect, and improve local air quality and/or reduce PAH exposure. Results would also provide guidance on the advantages and consequences of the densification of aircraft take-off and landing routes. Analyses will provide insight into what changes should be implemented, if any, to preserve, protect, and improve local air quality.

**II. PROJECT ACTIVITIES AND OUTCOMES**

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| **Activity 1 Title: Model development****Description:** *Preparation, procure all software and hardware required, training, determine and finalize emissions factors to convert VOCs into speciated organic gases***ENRTF BUDGET: $10,000** |  |
| **Outcome** | **Completion Date** |
| *1. All hardware and software for modeling activity 2 is procured* | *Sept, 2020* |
| *1. All information needed to run accurate models* | *Dec, 2020* |

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| **Activity 2 Title: Modeling****Description:** *Use AEDT software to model emissions of PAHs and air toxics as a function of weather, season, location, air patterns (dispersion of plume), etc***ENRTF BUDGET: $56,400** |  |
| **Outcome** | **Completion Date** |
| *1. Maps showing modeled concentrations of PAHs and air toxics as a function of weather, season, location, air patterns (dispersion of plume), etc. We expect about 50 cases to be evaluated and presented* | *Dec, 2021* |

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| **Activity 3 Title: Context and dissemination****Description:**Review literature and analysis to put emissions levels in context with 1) concentrations that are health-relevant, 2) emissions due to other sources (vehicle traffic). Emissions maps (activity 3) will be shared with stakeholders in the following ways 1) submitted to <http://mspfairskies.com/> for posting online, 2) published in peer-reviewed literature, 3) presented to residents in a public forum tbd.**ENRTF BUDGET: $20,000** |  |
| **Outcome** | **Completion Date** |
| 1. Literature that put emissions levels in context | *Sept, 2021* |
| 2. Peer-reviewed paper, knowledgeable stakeholders | *Sept, 2021* |
| 3. Knowledge of what appropriate actions, if any, are required to reduce the impact of air pollution on residents in neighborhoods surrounding MSP to acceptable levels | *Sept, 2021* |

**III. PROJECT PARTNERS AND COLLABORATORS:**

The project will be led by Prof. Jacob Swanson of Minnesota State University, Mankato and a small team of undergraduate engineering students. Prof. Swanson is internationally recognized for his work on emissions from engine combustion engines, including those from gas turbines. Activity 3 dissemination activities will be assisted by the City of Minneapolis’ air quality analysts.

**IV. LONG-TERM IMPLEMENTATION AND FUNDING:**

We will seek continuation funding so that model results can be expanded to other pollutants of interest (e.g. NO, NO2, PM, etc). In parallel with this work, a proposal will be submitted to a FAA grant proposal under FAA-12-01 – Chapter I. FAA Research Grants Program, Technical Areas of Research #7. The proposal will support extension of our work. Additional funding will allow for some model validation with the two nearest air quality modeling stations and perhaps with historical results since flight paths are archived. Ultimately, this software is also capable of noise modeling which could possible support concerns about the existing noise thresholds used, the metrics reported, and the independency of the results. Data, models, and lessons learned will increase opportunities for successfully procuring this additional funding.

This project will take two years to complete We are planning for six months of set-up and purchasing, one year of gathering data, and six months to compile data and disseminate data.