EXHIBIT F

UTC Project Information	
Project Title	Multiscale model for hurricane evacuation and fuel shortage
University	Embry-Riddle Aeronautical University
Principal Investigator	Sirish Namilae
PI Contact Information	Aerospace Engineering Department, 600 S Clyde Morris Blvd, Daytona Beach, FL 32114 Email: namilaes@erau.edu, PH: 386-226-6445
Funding Source(s) and Amounts Provided (by each agency or organization)	Total - $134,998 =DOT-CATM- $89,998 + ERAU (cost share) $45000
Total Project Cost	$89,998
Agency ID or Contract Number	69A3551747125 (Awarding agency contract #)
Start and End Dates	Contract date - 03/18/2019 Project start and end dates: 10/1/2018-9/30/2019
Brief Description of Research Project	Recent hurricanes in Southeast United States have led to mass evacuations. During the last year's hurricane Irma, 23 counties in Florida issued mandatory evacuation orders, with the remaining 44 counties putting in place voluntary orders. Our analysis of hurricane Irma traffic data obtained from Florida Department of Transportation (FDOT) indicates a net exodus of 550,000 vehicles from the southern parts of Florida. It is estimated that approximately 6.8 million Floridians and tourist took to the roads in the days leading up to the storm [1]. Such mass evacuations have also been observed during recent hurricane Florence [2] affecting North and South Carolinas as well as during this month's hurricane Michael [3]. Hurricane evacuees tend to make longer, intercity trips to stay with friends and family outside the impacted area and to completely move out of the storm path [4]. The high volume mass evacuations, disruptions to the supply chain, long distances travelled, fuel hording from non-evacuees have led to localized fuel shortages lasting several days in all of recent hurricanes including Irma,

	Florence and Michael (see figure 1). Fuel shortages further exacerbate safe evacuation of residents in affected areas. While news reports have documented fuel shortages during past hurricanes, crowd-sourced data from social media platform gas buddy [5] has quantified the shortages during recent hurricanes. A predictive model of fuel shortages during hurricane combined with on-ground traffic and fuel data will be effective in providing policy suggestions for both effective evacuation and back-up fuel storage locations. *We propose a computational model at multiple scales to predict the fuel shortages that develop during hurricane evacuation.*
Describe Implementation of Research Outcomes (or why Not implemented) Place Any Photos Here	We will develop a multiscale framework with multiple components including: I. Compartmental stochastic *epidemic spread model for fuel shortages* at city and state level. II. Traffic data from past hurricanes (e.g. Irma and Florence), combined with a Monte Carlo fuel consumption model to estimate fuel usage. III. Self-excitation point process model to delineate and *estimate baseline and contagious fuel consumption* (e.g. fuel hoarding, effect of nearby refueling stations emptying). IV. *Agent based discrete event simulation model* for detailed analysis at the scale of few intersections. V. *Policy analysis* using a predictive model for future hurricanes based on the above.
Impacts/Benefits of Implementation (actual, not anticipated)	1. Developed a compartmental stochastic epidemic spread model for fuel shortages at city and state level. 2. Developed an optimal control mathematical model for refueling. The model uses Bang-Bang Control method and applies a vaccination analogue to assess the best strategies for refueling. 3. Anylogic agent based simulation of automobile of highway intersection with six gas stations
Web Links • Reports • Project Website	http://pages.erau.edu/~namilaes/Fuel_shortage1.pdf Links to reports will be added on project completion