Submitting to: *The 6th Triennial International Aircraft Fire and Cabin Safety Research Conference*
Topic: *Systems Safety Fire/Fires in Nonpressurized areas*

Pool Fire Stability Downstream of Circular Cylinders in an Engine Nacelle Environment

John M. Davis
Engineering & Scientific Innovations, Inc.
Cincinnati, Ohio
jdavis@esi-solutionsinc.com
513-605-3700

Peter J. Disimile
UC-FEST, Dept. of Aerospace Engineering
University of Cincinnati
Cincinnati, Ohio

Currently, fire suppression systems are specified for all remote areas of an aircraft that have a high potential for fire. Due to the high cost of production aircraft, much of the test and evaluation of fire suppression systems is performed using full-scale, ground-based simulators. Since the cost of these simulators is directly related to the size of the test article and the level of geometric detail included, only salient geometric features are currently modeled, such as large ribs or spars, main fuel lines, wire bundles, etc. As a result, small spars, surface protrusions, individual hydraulic or fuel lines, standoffs, etc., are usually omitted. Although this strategy may have minimal impact on fire test results in the absence of airflow, in the presence of airflow these elements could substantially alter the test and evaluation outcome. However, simulator designers currently have little to no basis to determine the level or size of geometric detail required to provide an accurate representation of a given platform in a fluid-thermal sense.

The current paper highlights the results of a study conducted to examine the effect of smaller obstructions on flame stability in a confined flow representative of a generic aircraft engine nacelle. The results show that the larger obstructions acted as flame holders by creating a wake stabilized flame completely confined within the downstream recirculation region of the obstruction. The smaller obstructions were observed to create rim-stabilized wrinkled flames which significantly affected flame stability at distances well beyond that observed for the wake stabilized flames created by the larger clutter elements. This phenomenon is shown to be attributed to an increase in the small scale turbulent mixing close to the liquid fuel surface. Furthermore, the results indicate a possible minimum clutter size, below which the turbulent airflow and flame stability properties remain constant. This cut-off is of importance to fire safety engineers in the design of robust simulators for modeling and experimental fire safety test programs, by providing the data necessary to allow the omission of certain clutter elements with minimal impact on the fire test result.