AFRL CALL FOR RESEARCH

1. **Research Title:** *Modeling the effect of Surface Interactions on Two Phase Flow and Heat Transfer in Horizontal Pipes*

2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level:** Mechanical, Chemical or Materials Engineering / computational fluid dynamics, computational materials science (MS or Ph.D.)

4. **Objectives:** Gas-liquid two phase flow plays a major role in a number of cooling technologies used in thermal management of aircraft systems. To control and design the heat transfer behavior of these devices, it is essential to have a fundamental understanding of the flow characteristics, such as the flow regimes and pressure drop. Along with a number of other factors that influence this multiphase flow behavior, interfacial effects have emerged to be significant in determining the flow characteristics. The objective of the present effort is to develop high fidelity models that can investigate the role of surface effects such as surface energy, wettability, interfacial forces and surface roughness on two phase flow resistance and subsequent heat transfer behavior of horizontal pipes.

5. **Description:** The goal of this 3-year DAGSI project is to use modeling and simulation to develop a better understanding of the role of surface effects on two phase flow in horizontal pipes. Present results indicate that two-phase flow resistance in narrow pipes is a strong function of surface wettability and increases with static contact angle. Change in hydrophobicity, surface tension and wettability, all are found to significantly alter the flow resistance and pressure drop. Evidence is also seen of wetting and dewetting transitions with change in surface roughness. All this indicates that the wettability parameters and interfacial forces have to be accounted appropriately. CFD simulations although very successful in developing and validating multiphase flow models have been less successful in investigating problems such as discontinuities at solid-liquid-vapor interfaces and wetting, nucleation and coalescence phenomena. In this project, special emphasis will be put on improving CFD models by augmenting with results on fluid properties and behavior from molecular dynamics simulations. The Air Force Research Laboratory is actively developing two phase cooling systems for high heat flux thermal management issues of high performance aircrafts. DAGSI researchers will collaborate with researchers at AFRL to develop high fidelity heat transfer models with predictive capabilities.

6. **Research Classification/Restrictions:** U.S. Citizens only. This research falls under the 6.1 basic research classification and as such has no restrictions. However to facilitate close collaboration between AFRL and the student, frequent visits to WPAFB will be required.

7. **Interest in Summer USAFA Cadet:** No

8. **Eligible Research Institutions:** All

[X] Universities (DAGSI) [X] AFIT (only) [ ] USAFA