Fiscal Year:	FY 2023	**Task Last Updated:**	FY 03/07/2023
PI Name:	Pitz, Robert Wendell Ph.D.		
Project Title:	Effect of Stretch and Curvature on Cool Flame Transitions and Structure Using Tubular Flames		
Division Name:	Physical Sciences		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	COMBUSTION SCIENCE--Combustion science		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	None		
Human Research Program Risks:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	37235-0001	**Congressional District:**	5
Comments:			
Project Type:	Ground,Physical Sciences Informatics (PSI)	**Solicitation / Funding Source:**	NNH21ZDA001N-PSI:Use of the NASA Physical Sciences Informatics System – Appendix E
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No. of Bachelor's Candidates:		**Monitoring Center:**	NASA GRC
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Flight Program:			
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Task Description:	Cool flames are important in knock formation in internal combustion engines and in modern engine concepts operating at low temperature to achieve high efficiency and low pollution. Cool flames have been observed on the International Space Station in droplet combustion in a quiescent chamber where cool flames appeared after the hot droplet flame extinguished due to radiation. Cool flames in practical devices are subject to flow unsteadiness that stretches and curves the flames. Under NASA Physical Sciences Informatics (PSI) Research Announcement science, flat cool premixed and diffusion flames in the presence of fluid stretch have been studied in opposed-jet flames that feature the interplay of finite-rate chemistry, molecular transport, and heat transfer, including radiative extinction. In opposed-jet burners, flat cool flames can transition to warm flames and hot flames with each transition driven by different chemical reactions. Flame regimes have been determined in flat cool premixed and diffusion flames, including transitions between cool, warm, and hot flames, formation of multi-stage flames, and flame extinction. Flames in nature are not flat. Studies in opposed-jet flat cool flames lack the presence of curvature found in practical internal combustion engines. The curvature of tubular flames is expected to change where the cool flames transition to warm and hot flames, as well as stretch rate extinction values. Curvature and stretch rate are also known to produce cellular structure in flames. In this study, cool premixed and diffusion flames in tubular flames will be investigated both computationally and experimentally to determine the effect of curvature on cool flame regimes, transition to warm and/or hot flames, flame structure, multi-stage flame formation, and extinction stretch rates. The project will use data from PSI system listed as Investigation #12 in Table A of the Program Element entitled, "Quantitative Studies of Cool Flame Transitions at Radiation/Stretch Extinction using Counterflow Flames" (https://). The computational and experimental study will expand upon this original investigation to determine the additional effect of curvature on the cool flames in terms of their transitions and structure, including cellular formation. In this study, cool flames in the tubular flame geometry will be investigated both computationally and experimentally. Gaseous fuels (dimethyl ether) and liquid fuels (dibutyl ether) will be investigated in the tubular burner to parallel earlier studies in flat, opposed-jet cool diffusion and premixed flames. The regime diagrams, flame transitions, flame structure, multi-stage formation, and extinction conditions will be determined computationally using the Vanderbilt Tubular Flame Code as a function of pressure. The detailed numerical simulation (DNS) code includes detailed molecular transport, complex chemical kinetics, and radiation heat loss. The cool tubular flame structure will be measured with advanced laser diagnostics. Raman scattering will be used to measure the flame temperature and major species concentrations. Planar laser-induced fluorescence (PLIF) of CH2O and chemiluminescence will be used as a marker of the cool diffusion flame. The tubular flame experimental and computational results will be compared to the previous cool opposed-jet results to determine the effect of curvature on the cool flame transitions, structure, multi-stage flame formation, and extinction. Cool premixed and diffusion flames are found in diesel engines and other modern internal combustion engine concepts such as homogeneous charge compression ignition (HCCI), reactivity controlled compression ignition (RCCI), and partially premixed compression ignition (PCCI). Understanding the effects of curvature and stretch rate on cool flame transitions and structure will lead to better insight into cool flame propagation in practical internal combustion engines.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2023.
Bibliography Type:	Description: (Last Updated: 02/18/2011)