Project title:

Blue flame burners to improve fuel oil stove efficiency

Applicant Contact Information:

Alaskan Burner R&D
William Manning
2073 Pumice Ct.
North Pole, AK 99705
(907) 488-1892
Cell (907) 378-9581
Email: alaskaninnovations@hotmail.com
Web: www.alaskaninnovations.com

Partners:

University of Alaska Fairbanks, Geophysical Institute
Alaska Manufacturing Extension Partnership, Inc.

Project Cost:

Total Project Cost: $467,120. Grant funds requested $400,000. Match committed $67,120.

Previous projects/applications:

There are no previous grant applications or awards for this project.

Previous Project Title for EETF Abstracts:

None.

A. Project Description: Alaskan Burner R&D was formed to research & develop high efficiency oil burners for residential and commercial heating systems throughout Alaska. The resulting research led them to develop a burner to take advantage of B.L.E.V.E. (Boiling Liquid Expanding Vapor Explosion) technology to create blue flame efficiency and increase flame temperatures from around 1,400°F to around 3,000°F. Based on secondary research, this B.L.E.V.E. technology, when harnessed into a Blue Flame Burner (BFB), can greatly reduce fuel consumption, primarily through improved combustion efficiency. B.L.E.V.E. technology has the potential to reduce home heating fuel bills by up to half, which would be a dramatic savings for rural homes across Alaska. To date, Alaska Burner R&D has used their own funds and sweat equity to develop this project. AB R&D have arranged for matching funds from third parties contributors if grant funds are awarded.

The purpose of Blue Flame Burners (BFB) is to burn fuel oil more efficiently. All current oil fired burners are yellow flame in nature. Yellow flame burner temperatures range between 1,400°F and 2,000°F depending on a number of factors like heater age & manufacturer. Fuel oil needs to reach a minimum temperature of 2,174°F to fully burn all combustible portions of the fuel. Current burners are not designed to achieve the high temperatures required to produce the desired combustion efficiency because the liquid fuel oil is sprayed into the combustion chamber and ignited. The nozzles don't fully gasify the oil before combustion. Yellow flame burners average 51% absolute maximum burning efficiency. (http://inspectapedia.com/heat/Blue_Flame_Combustion.htm - Herman Vogel aerospace engineer)

B. Project Eligibility: Alaskan Burner R&D LLC (AB) was started in June 2011 by William Manning and is operated in North Pole, Alaska, and is an Alaska company. The three members of the LLC (William Manning, James Manning, Glenn Pearson) are all Alaska residents.

C. Project Innovation: Blue flames burn at an average temperature of 3,000°F which means that all combustible portions of the fuel is utilized. Blue flame burners average 78% absolute maximum burning efficiency. (http://inspectapedia.com/heat/Blue_Flame_Combustion.htm - Herman Vogel aerospace engineer). Blue Flame Burners achieve these higher combustion temperatures by utilizing an advanced burner/nozzle assembly and controller design that can retrofit into existing heating units or used in new heating systems. The Blue Flame Burner system in development by Alaskan Burner R&D will improve fuel efficiency in oil fired heating systems by 27% (78% – 51%) thereby reducing fuel usage by 27%. A 27% reduction in fuel use is a substantial savings to rural Alaska communities.

Alaskan Burner R&D's Blue Flame Burner utilizes existing technologies and materials integrated into an innovative solution for energy efficiency. The Blue Flame Burner system consists of a burner/nozzle assembly and controller that will replace existing burners, controllers and igniters. The basic idea of the design for the Blue Flame Burner is a burner housing that contains a B.L.E.V.E. chamber, induction heating element, solenoid, nozzle, orifice and sensors that are controlled and monitored by a digital control unit. The controller signals the nozzle assembly to let a measured amount of fuel into the B.L.E.V.E. chamber of the nozzle assembly where it is heated to a vaporization temperature above the

auto ignition point of the fuel, it is then released into the burn chamber through the orifice of the nozzle. The vaporized fuel ignites on contact with the oxygen in the burn chamber. This cycle happens in about 1/100th of a second and is repeated as long heat is needed. The controller monitors and adjusts the burner to maintain optimized burn efficiency, temperature and minimize emissions within pre-programmed parameters producing a clean burning blue flame.

Project Priority: This project meets the priority criteria because the applicant is an Alaska organization with Alaskan ownership, it is conducted in partnership with the University of Alaska Fairbanks, it is supported by match and partnership with the Alaska Manufacturing Extension Partnership, Inc. and includes in-kind from the applicant, and it has the potential to offer significant fuel oil savings for homes all across Alaska.

Technology Validation and Research Methodology

A. Objectives: This project objective is to construct and test three separate technologies needed to create the BFB (ceramic B.L.E.V.E. chamber, nozzle, controls), and integrate these technologies to create a complete full-scale BFB system capable of retrofitting into an existing home heating unit, at readiness level of TRL 7.

B. Methodology: The two main components of the blue flame burner system consist of the computerized controller and the burner/nozzle assembly. The burner/nozzle assembly is made up of the following components: nozzle & orifice, B.L.E.V.E. chamber, induction coil heater, solenoid valve, and temperature sensor. There is an oxygen sensor and CO sensor that mount remotely on the boiler/furnace to provide combustion data to the controller. An electronically controlled air valve will be installed in the combustion intake so the controller can manage combustion air for efficient fuel burn. The controller also connects to existing sensors and equipment on the boiler/furnace.

Alaskan Burner R&D has produced the initial research, analysis, specifications and designs of the various components of the Blue Flame Burner system and has experimented with various types of materials for the nozzle and burner assembly. Test models of the various components are ready to be constructed and tested. Each component will go through a three-phase process of construction and testing to refine the design to its final version by the end of the third phase. After the design and function test of each component has been finalized, a complete Blue Flame Burner prototype will be assembled and demonstrated. Data will be collected during this process and consist of operating temperatures, emissions, fuel consumption, sensor accuracy, controller responsiveness to changes, and burner response to the controller.

Gregory Shipman, Manager, Engineering Design & Development at the Geophysical Institute at University of Alaska Fairbanks will be the Principal Investigator of the testing and research. Shipman will review the existing research, develop a research design to accomplish the objectives, oversee and report

on the testing and development of each of the three technologies (B.L.E.V.E. chamber, nozzle, and controller), and integrate these technologies to create the BFB system prototype.

William Manning is the Project Manager for the Blue Flame Burner project. He will oversee and organize the work as the project moves forward. Qualified specialists will be brought on board (paid or voluntary) and utilized as required for fabrication and testing. Any equipment required in the process will be provided by the specialists, rented or purchased. At each step in the process each person will document all findings, changes, and observations for their portion of the project. William will routinely gather the data, analyze and compile it into a meaningful format including statistical information and provide it to the people involved in the project that need it.

Alaskan Burner R&D has a 576 sq ft facility in North Pole, Alaska that provides office and work space for the Blue Flame Burner project. The facility has sufficient space for the administration and implementation of the project. It is close to UAF and provides ready access to UAF faculty and students working on the project. Mr. Shipman may choose to conduct some or all of the testing in UAF facilities. Winter temperatures in North Pole are frequently in the -30° to -50° range making it an ideal place to research and test heating products and their efficiency.

Summary of Project Schedule and Summary of Project Budget

	Round 1 Testing		Round 2 Testing		Round 3 Testing		Final	**Grand**
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	**Total**
Controller	10,000	10,000	20,000	20,000	20,000	20,000	10,000	$110,000
Chamber	10,000	10,000	10,000	10,000	5,000	5,000	5,000	$55,000
Nozzle	15,000	15,000	15,000	15,000	10,000	10,000	15,000	$95,000
Prototype Ass'y					20,000	40,000	25,000	$85,000
Design & Report	5,000			4,000			4,000	$13,000
Management	6,000	6,000	6,000	6,000	6,000	6,000	6,000	$42,000
Total Grant	**46,000**	**41,000**	**51,000**	**55,000**	**61,000**	**81,000**	**65,000**	**$400,000**
In-Kind Match:								
Mgmt-AB	6,000	6,000	6,000	6,000	6,000	6,000	6,000	$42,000
Facilities lease	2,160	2,160	2,160	2,160	2,160	2,160	2,160	$15,120
Biz Plan-AMEP	2,000			2,000	2,000	2,000	2,000	$10,000

Total In-Kind	**10,160**	**8,160**	**8,160**	**10,160**	**10,160**	**10,160**	**10,160**	**$67,120**
Total Project								$467,120

Project Team Qualifications

William Manning – Responsibilities: Lead researcher, design, and technical writing – Qualifications: AAS Degrees in Industrial Engineering, Electronics, and Telecommunications from Iowa Central Community College. 20 years on the job experience with heating systems, electrical and plumbing.

James Manning – Responsibilities: Research, Program Engineering - Qualifications: BS degrees in Computer Science and Geology, Minor in Mathematics. 13+ years on the job experience with IT, computer software design, programming, and system administration.

Glenn Pearson – Responsibilities: Fabrication and Technical Design Engineering - Qualifications: 30+ years on the job experience with fabrication and design of HVAC and burner systems.

Gregory Shipman – Engineering Design & Development, Geophysical Institute, University of Alaska Fairbanks –Responsibilities: Shipman will be the Principal Investigator for the testing of all three technologies and the assembly of the BFB.
His 32-year career in mechanical engineering, precision machinist, R&D design, fabrication, engineering draftsman, and CAD provide ample experience to build upon the existing research to apply valid and reliable methods of testing that will solve problems, allowing him to design and make a complete BFB system to the TRL 8 standard.

Discussion of Commercialization of Funded Technology

Residential fuel oil usage in Alaska is approximately 63,813,000 gallons per year (5 yr average, http://www.eia.gov/dnav/pet/PET_CONS_821USE_DCU_SAK_A.htm). Fuel oil prices in Alaska Range from $3.60 to $8.00 per gallon depending on how remote the location is. The Blue Flame Burner is at least 27% more efficient and has the potential to reduce residential fuel oil usage by up to 17,229,240 gallons per year. At $3.60 that would be a savings of $62 million per year.

The BFB system will be at a Technology Readiness Level 8 upon completion of the project. It will be patented, and licensed to national and international fuel stove manufacturers for installation in new stoves. The retrofit market licensing will be handled separately, and terms will require the manufacturer of the BFB system to offer the retrofit to distributors who operate in Alaska. The manufacturer who secures licensing rights will conduct the final engineering, design for manufacturing & assembly, and regulatory compliance within their corporate framework. AMEP will assist AB in the preparation of the business plan, in the partner search, and in the licensing activities. These final manufacturing and regulatory steps can be accomplished within one year by any established heating system company, which gives the project a high likelihood of commercialization within five years.