Defense Production Act (DPA) Title III – High Energy Density Alane Fuel Manufacturing for DoD Systems Project
Call 001
Statement of Objectives (SOO)

1.0 SCOPE

This Title III project shall establish domestic, economically viable, cost effective production capabilities for the manufacturing of aluminum hydride, also known as alane, for use with various fuel cell systems. This project shall support a path towards mass production and cost reduction for stable crystalline alane (alpha alane) and enable future advancements such as quality improvements, critical lead-time reduction, and accommodate potential surge needs of the government. The proposed initiative will support development and construction of a pilot line to meet Army, Air Force and Navy needs. This effort will prove out the capability to produce alane at a small scale and provide the government information related to requirements for scaling up production. Based on satisfactory results of and the information provided related to scaling up production as required in this SOO, the government, at its discretion, will begin work with industry to structure an effort that will establish the large scale capacity to meet developing military and commercial demands.

2.0 BACKGROUND

As the Department of Defense (DoD) develops the next generation of weapons, from those worn by the individual warfighter to large aerial and underwater systems, there is an increased reliance on technologies that consume significant amounts of electricity. When the platform cannot support an engine due to size or other reasons, the military is left with one option, a battery. However, the military systems of today and tomorrow are eclipsing the limits of batteries, even advanced rechargeables, which require a separate ‘charging’ infrastructure further complicating their use; therefore a significant need exists for a lightweight, independent, safe and quiet power system.

In response to these shortcomings the DoD has been actively developing several fuel cell technologies. Fuel cells have excellent energy characteristics and are light weight with simple refueling. This enables longer mission times and the ability to carry other mission enablers. While the military investigated many different hydrogen sources, the one that has stood out as the most promising and able to fit in our logistics structure is alane. The major advantages of alane are (1) high energy content for a small weight and volume; (2) safe and simple usage; (3) harmless reaction products and minimal environmental impact and (4) long shelf life.

The significant disadvantage of alane is the lack of any large volume commercial production capacity. While synthesized successfully at a costly laboratory scale, this material has not been transitioned to mass production to reduce cost and enable mission support. This material has significant commercial interest, but the lack of proven low-cost mass production has kept commercial fuel cell interest minimal. Investing in the processes and production capabilities to reduce the cost of alane will undoubtedly renew commercial interest as a side benefit to the military. With DPA Title III support, commercial chemical manufacturers will be provided the financial support to invest in this promising fuel, thereby making strides towards stable economical levels, while in the meantime the DoD can take advantage of this promising mission enabler.

3.0 OBJECTIVES

The objectives identified in Sections 3A, 3B and 3C are standard requirements for a Title III project. The objectives identified in 3D are the specific technical requirements for this particular project.

A. Program Management, Administration, and Reporting

1. Manage and implement the project. Monitor and control the project's cost, schedule, and performance parameters.

2. Establish a cumulative monthly expenditure profile baseline for the government funds. Track the actual monthly expenditures and cost shares if applicable against the baseline and report it to the government quarterly.

3. Participate on the project's Stakeholder (government and contractor) Integrated Product Team (IPT) and interface with Title III project managers and contracting (agreements) personnel.

4. Conduct regular technical update meetings/teleconferences, calls and Quarterly Program Management Reviews (PMR). Up to two PMRs in any year may be conducted at the recipient's facility, and at least one PMR per year may be conducted at a government location. Remaining PMRs may be conducted by conference call. Key sub-recipients and/or subcontractors should actively participate in PMRs.

5. Conduct a Technical Project Kickoff Meeting no later than 60 days following award.

6. Continue to insure, maintain, operate and service all government and non-government owned capital equipment and tooling as required to establish a domestic alane manufacturing capability.

7. Update and provide the Government Equipment Property List at the time of quarterly PMRs and as required. If equipment is procured using Title III funding, prepare for a Monitoring Phase (MP) after the conclusion of the technical effort to demonstrate acceptable utilization and maintenance of the government equipment in support of the long-term goals of this project.

8. Establish and track Key Performance Parameters (KPPs) with DPA Title III IPT concurrence. Baseline capabilities, Threshold (minimum), and Objective (stretch) targets should be established for at least two KPPs in each of the following four categories: Technology, Manufacturing, Financial, and Marketing. Report KPP performance at quarterly PMRs or as required. Conduct initial and final manufacturing demonstrations to validate the baseline and final capabilities. Demonstrations may be conducted concurrently with planned production if feasible.

9. Provide input, assistance and support to the Title III team in conducting a baseline and a final Manufacturing Readiness Assessment (MRA) of alane manufacturing capabilities.

B. Strategic Business Planning

1. Prepare, submit and implement a Strategic Business Plan that addresses the key aspects of a commercial manufacturing facility for alane in military and commercial applications. Submit the initial plan six months after initial award.

    a. In addition to the standard topics suggested in the strategic business plan template, the recipient shall specifically address its supply chain management strategy, ability, and plan to secure its present and future supply of qualified critical source materials to remain a viable merchant supplier of alane.

    b. The comprehensive strategic business planning should cover a minimum outlook of 24 months (estimated), including all financial statements, actual and forecasts.

c. Provide performance-to-plan evaluations at regular intervals, with management review comments, to Title III so long as a contractual relationship exists.

2. Include in the plan the key issues related to the establishment of a competitive and commercially viable merchant supplier of alane.

a. The recipient shall certify they meet the criteria in the "Certification Regarding Merchant Supplier – Defense Production Act, Title III" article.

b. In the event that the recipient is not presently a merchant supplier, the recipient should provide a credible strategy in its strategic business plan demonstrating how it will become and remain a merchant supplier.

C. Market Planning and New Business Development

1. Prepare, submit and implement a Marketing Plan. Submit the initial plan nine months after initial award.

2. The strategic marketing plan should address current and future customer needs (domestic and foreign, civilian and military) for alane.

a. Survey and be responsive to, and report to the government on, (DoD and commercial) customer needs, requests and trends for all types of alane.

b. Define plans/opportunities to use material market development including packaging/cartridge demonstrations and research.

c. Provide performance-to-plan updates at regular intervals, including reports on business capture plans (target business awards, actual awards and missed opportunities) to Title III so long as a contractual relationship exists.

D. Manufacturing Process Development

1. Establish a small functional, production-representative scale operation capable of manufacturing alane using the attached draft specification (see attachment 1) as a goal for a commercially viable product. The production representative scale operation shall not be a "lab synthesis" and should demonstrate all the steps necessary for "cost effective" production of alane including reagent recycle, optimized yield and adequate controls for reproducibility. The production representative scale should also

demonstrate that all environmental health and safety regulations are met. Provide an adequate description of this scale operation and how it is similar, and dissimilar, from a larger, scaled-up plant. Technical information provided shall describe equipment and processes on the small scale operation with corresponding applicability to larger operations in subsequent effort, demonstrating sound modeling practices and analysis to support confidence in increasing this scaled down design to target size. Describe potential and perceived risks associated with the scale-up and processing conditions for the various operational steps and risk mitigation strategies that will be employed to alleviate the risks and aid in a smooth transition to subsequent increases in scale.

a. Develop plans for this effort including already existing equipment/facilities planned to be used, and required purchases (new capital equipment and facility enhancement items). The plans should support the most sensible scale and indicate the estimated amount of alane the production-representative scale operation could make in a year if operating a normal one shift operation.

b. The government is not specifying the size of the 'small scale' operation but it should, as a minimum, be within the 2-5 kg per batch range. Develop a rigorous cost analysis for this “small scale” of operation and identify an alane $/kg estimated cost of the proposed 'scaled' plant (in kg/yr). Include in the cost analysis a complete breakdown of the capital, labor, raw material and energy costs associated with the proposed scaled operation to support the projected $/kg estimate for alane cost.

c. Develop plans to reduce the costs associated with the raw materials required to produce alane, or processes that require less expensive raw materials.

d. Develop detailed plans for increasing production to meet forecasted market volumes at viable target fuel costs for operation of military and commercial applications. Vendors may be asked to provide rudimentary plans and estimates for a variety of sizes based on availability of funds, program targets and operation costs. These plans should discuss cost to construct, cost to run, material costs (including final alane) and business operational issues to ensure commercial viability. Once the Government has finalized a size range, it may pursue a scaled up operation as part of a competitive follow-on effort. The vendor will be asked to develop more detailed plans and estimates for that target sized plant.

e. The recipient shall identify and establish manufacturing key performance parameters (KPPs) for the production of alane against which targeted objectives to be achieved will be compared, tracked, and periodically evaluated during the program.

2. Initial alane chemistries from multiple batches shall be tested at an independent lab that is approved by the government to ensure consistent production capability. The cost of materials for theses batches can be included in the partnership cost sharing agreement. Recipient shall prepare and submit an alane chemistries report that shall include detailed analysis of the test results from the independent lab, and shall be compared and corroborated with the recipient's analytical results against the Government's alane specification/requirements. Should the alane sample material not meet expected performance characteristics, the Government reserves the right to halt or redirect funding to improve the processes until alane can be demonstrated according to specs/requirements.

3. The recipient shall conduct a DoD Manufacturing Readiness Assessment (MRA) of the final production capability for producing alane. The culmination of the final MRA shall include a visit by the Government IPT to review the manufacturing and process control steps demonstrating the recipient's ability to successfully and repeatedly manufacture qualified alane. The final MRA/Government IPT review shall be conducted at the conclusion of both the independent alane chemistry testing and fuel cell qualification. It may also be conducted in conjunction with the project closeout meeting.

4.0 SECURITY REQUIREMENTS

A. Operations Security (OPSEC) Requirements

All recipients shall participate in all activities associated with the disciplines of the organization's Industrial Security, Information Security, Personnel Security, Operations Security (OPSEC), Antiterrorism, and Program Protection programs, following appropriate measures in each program as required for this particular agreement. These are required in an effort to reduce program vulnerability from successful adversary collection, exploitation of critical information, and violations of export control requirements. The recipient will ensure that all sub-awardees, if required, conform to these requirements as required by the recipient. Air Force Research Laboratory Materials and Manufacturing Directorate (AFRL/RX) Security can provide guidance as needed.

B. Program Protection Plan (PPP)

Any potential critical program information (CPI) generated, as part of this effort, will be reviewed to determine the need for a PPP.

C. Foreign Participation: Not at prime recipient level.

Foreign Nationals (FNs) can be employed by the U.S. Prime Recipient or Sub-awardee; however, FNs will be limited to Public Domain information unless the recipient has obtained the proper License of Technical Assistance Agreement that authorizes disclosure of CMI and/or CUI to foreign entities pursuant to the Department of State's International Traffic in Arms Regulations (ITAR) or Department of Commerce's EAR.

Public Domain information is defined as information that is releasable to the general public and sometimes referred to as open source material. Examples include but are not limited to newspapers, magazines and information posted on the internet.

Any proprietary information will have to be appropriately protected.

5.0 DELIVERABLES

The following reporting requirements are defined in Call 001:

Deliverable Item	Submittal Requirement
7.040 Final Report	3 months after conclusion of technical effort
7.050 Funds & Man-hour Expenditure Report	Quarterly
7.052 Contractor's Progress, Status & Mgt Report	Quarterly
7.054 Strategic Business Plan	6 months ARA
7.055 Property Control List	Quarterly / As Required
7.057 Presentation Material	Quarterly / As Required
7.060 Marketing Plan	9 months ARA

* After Receipt of Agreement or Award (ARA)

DRAFT ALANE SPECIFICATIONS

	Attribute	Specification Value	Test Method/Reference
Material Properties	Chemical Formula	AlH_3	N.A.
	Molecular Weight	29.99 g/mol	N.A.
	Crystal Size	1 micron	Scanning Electron Microscope (ISO 13322-1)
	Density	1.49 g/cm^3	Powder Tap Density
Temperature Stability	Hydrogen Content	10% by weight	ASTM Standard E1131-08 with < 0.5% weight loss up to 170 C and >9.5% and <10.1% weight loss at 240 C
	Onset Temperature for Hydrogen Evolution	180°C	N.A.
	Simulated Bulk Auto-Ignition Test (SBAT) 10°F/hr heating rate	250°F	N.A.
	Hydrogen Loss when tested as loose powder (must conform to both tests)	a) <0.01% at 25°C in 1 year <60 torr pressure increase when a 19 mg sample in 25 ml evacuated volume is held at 80°C for 100 hours	Thermogravimetric Analysis (ASTM E1131-08) or similar
Polymorphs/Composition (Solid requirements)	– Alane	100% objective – 95% threshold	X-ray Diffraction
	Other polymorphs (α', β, γ, etc.)	b) <0.01% each	X-ray Diffraction
	α Alane Etherates	<0.01%	Gas Chromatography/Mass Spectrometry (ASTM D2650-10), Residual Gas Analysis
	Other Alane Adducts	<0.01%	Gas Chromatography/Mass Spectrometry (ASTM D2650-10), Residual Gas Analysis
	Aluminum (Al)	<0.01%	X-ray Diffraction
	Chlorine (Cl)	<0.02%	Gas Chromatography/Mass Spectrometry (ASTM D2650-10), Residual Gas Analysis
	Stabilizers	<5%	
Hydrogen purity and contents	Evolved Hydrogen Purity (Gas requirements)	See Reference	SAE J2719 and ISO 14687-2
Transport/Handling Stability	α MBOM Impact Threshold Initiation Level (TIL)	9.54 x 10^4 J/m^2	Modified Bureau of Mines Impact Test
	Friction Sensitivity	75 lbf	ABL Friction (TIL) at 4 ft/s
	Electrostatic Discharge Sensitivity	>0.000613 J	ABL Electrostatic Discharge