

# Department of the Navy SBIR/STTR Transition Program

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ONR Approval #43-7504-20

Topic # N16A-T021

High Performance Energetic Propellant Ingredient Process Research and Development

NALAS Engineering Services Inc.

## WHO

**SYSCOM:** ONR

**Sponsoring Program:** PEO IWS; LCS Surface Warfare Mission Package; Hellfire

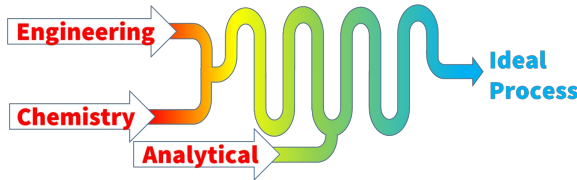
**Transition Target:** Low energy exploding foil initiators (LEEFIs) used in AIM-9X, RAM, ESSM, Standard Missile, Spider, FBM ordnance, FMU-139 Product Improvement Program, MEMS Distributed Initiation Systems, and SECAT Advanced Lightweight Torpedo Program.

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**Other transition opportunities:** Nalas novel synthesis development efforts aim to significantly reduce the cost of CL-20 to enable adoption of CL-20 in high performance explosive and propellant applications. Navy thrust areas for energetic materials include high performance rocket propulsion and explosives to provide increased lethality with smaller warheads. As such, Programs of Record such as PMA-201 Precision Strike Weapons (Hellfire warheads), PMA-242 Direct & Time Sensitive Weapons (Hellfire propellant), and PMA-259 Air-to-Air Missile Systems (AIM-9X) may incorporate CL-20 as well. These areas of interest extend to the other services in the DOD as well.



Home of Advanced Manufacturing of Critical Materials



## WHAT

**Operational Need and Improvement:** To meet the needs of the future US military services, there is an ongoing need for the development of new energetic materials with higher performance and decreased sensitivity to thermal threats and physical shock and impact. Currently used energetic molecules have been in use for decades with little improvements in sensitivity and/or performance. CL-20 is the most powerful explosive compound ever produced and as such has long been in demand due to its high energy density. Although it was initially developed in the 1980s with subsequent decades of investigation into possible low-cost synthetic routes, its production remains prohibitively expensive for most propellant and explosive applications. Nalas' innovative solution to this cost challenge is the assembly of a precursor from low cost materials that can be converted directly to CL-20 without any further synthetic steps.

**Specifications Required:** The Navy is seeking energetic ingredients whose energy output exceeds HMX and with superior safe handling characteristics. In order for the energetic ingredient to transition, the route to manufacture it needs to have a minimal number of steps and inexpensive starting materials and reagents. The Navy desires the energetic ingredients to have a density greater than 1.8 g/cc, oxygen content greater than CO balance upon detonation, melting point >200°C, low vapor pressure, sensitivities better than TNT, low hydrogen & carbon and high oxygen & nitrogen content.

**Technology Developed:** Nalas's efforts on a novel synthesis route for CL-20 have focused specifically on cost reduction. With future continuous improvements, Nalas can drastically reduce the costs to generate CL-20. Nalas utilizes in-house expertise in chemistry, chemical engineering, process development, reaction kinetics and modeling, and process safety to not only develop a synthesis process but also develop predictive reaction models. These reaction models enable safe and expedient scale-up and transition to full scale manufacturing.

**Warfighter Value:** A low-cost CL-20 will finally enable true development and acquisition of propellants, such as solid rocket motors, that can fly faster and farther than current state of the art propellants. Also, this CL-20 can gain warheads up to 20% more explosive power without adding size or weight to a weapon system. All of this ties into the priorities of the Navy and DoD to regain military overmatch over our adversaries and ensure the safety of our warfighters.

## WHEN

Contract Number: N68335-18-C-0027 Ending on: April 30, 2021

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Optimization of intermediate synthesis	High	Low-cost route to penultimate CL-20 intermediate	3	4th QTR FY20
Intermediate isolation development	Med	Isolation of high purity	3	1st QTR FY21
Preparation of multi-gram quantities of CL-20	Low	Conversion of novel intermediate to CL-20 in high yield	4	1st QTR FY21
Generate conceptual commercial process	Low	Provide estimate ROM cost of CL-20 manufacture less than SOTA	4	2nd QTR FY21
Characterization of CL-20 by LLNL	Low	High purity epsilon-CL-20 meeting specifications	4	3rd QTR FY21

## HOW

**Projected Business Model:** Nalas is considering becoming a manufacturer of CL-20 and are looking into the logistical steps required to do so. Nalas plans on being the manufacturer of the chemical precursor to CL-20. Recently Nalas purchased a 75,000 sqft facility for the purpose of manufacturing critical chemicals for the DoD starting with the continuous manufacture of the energetic plasticizer BDNPA/F. Nalas began work on developing the continuous BDNPA/F process in an Army SBIR program. Subsequently, the promising results led to further Army investments to help advance the technology to the point of being ready for production and qualification of the material. Nalas intends to follow similar paths for other DoD chemicals, including CL-20 precursors.

**Company Objectives:** Nalas Engineering's objective for this project is to develop the novel manufacturing technology to provide a dramatically reduced cost CL-20 and to be the manufacturer of the CL-20 intermediate. Beyond CL-20, the mission of Nalas is to support our DoD customers with chemical process engineering and to be the premier transition agent for scaling novel chemistries. Our vision also includes being the preferred manufacturer and supplier of specialty critical chemicals for the DoD. Our manufacturing plans rely on our ability to develop modern, affordable, safe and environmentally-acceptable processes to provide a long-term solution to the US government's problem of lost or reduced US manufacturing of critical energetic materials. By having multiple revenue-generating product lines, Nalas will help secure the critical energetic material supply chain for the US government.

**Potential Commercial Applications:** Detonators for oil and gas exploration and mining as well as high performance commercial propellants.

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