

Special Notice 12-SN-0001
Special Program Announcement for 2012 Office of Naval Research
Research Opportunity:
“Energetic Materials Program”

I. INTRODUCTION:

This announcement describes a research thrust, entitled “Energetic Materials Program,” to be launched under the ONRBAA12-001, Long Range Broad Agency Announcement for Navy and Marine Corps Science and Technology which can be found at <http://www.onr.navy.mil/Contracts-Grants/Funding-Opportunities/Broad-Agency-Announcements.aspx>. The research opportunity described in this announcement specifically falls under numbered paragraph 1 of the “Naval Air Warfare and Weapons (Code 35)” sub-section. The submission of proposals, their evaluation and the placement of research grants and contracts will be carried out as described in that Broad Agency Announcement.

The purpose of this announcement is to focus attention of the scientific community on (1) the area to be studied and (2) the planned timetable for the submission of white papers.

II. TOPIC DESCRIPTION:

In order to further explore the technical areas of energy per volume, safety, and affordability, the Aerospace Science Research Division of ONR (Code 351), invites the submission of white papers from all those involved in related research activities.

Offerors are invited to present related work, on-going research activities and proposed future activities associated with the following areas:

- A. Energetic Ingredients (HMX performance with TATB sensitivity)
- B. Propulsion (AP Replacement, SRM-Based, New Polymers)
- C. Reactive Materials
- D. Disruptive Technology (Columbic Explosion, Cluster Materials, etc.)

Background:

The vision of the warfighter is to have flexible ordnance to meet the ever-changing Naval mission requirements that have evolved over the years as adversaries have continued to develop counter systems to the latest weapon systems. Today, the Navy wants to defeat a variety of targets by projecting power with safe, cost effective, well-performing ordnance.

This ordnance must be adaptable in size to fit a family of delivery systems; contain sufficient energy to meet long range intercepts, defeat the target; and be affordable. To be responsive, Navy S&T must provide: ordnance ingredient and formulation flexibility to meet specific future

Naval mission requirements; with significant cost savings; and be compliant with safety and environmental regulations.

Future mission requirements impose very challenging and conflicting demands for weapon systems. There must be significant enhancements in delivery energy in compact volumes, while being resistant to catastrophic failure in extremely stressful environments such as handling aboard carriers, high thermal and shock loading and long-time storage. The development of capable systems is essential to our national security as the Navy conducts its world-wide maritime mission.

Objective:

The Office of Naval Research (ONR) is interested in receiving white papers on:

a. Energetic Ingredients (HMX performance with TATB sensitivity)

This effort will exploit the use of theoretical molecular design, organic synthesis manipulation, and quantum chemical modeling to provide energetic materials which meet existing munitions performance while achieving IM compliance. The investigator will establish theoretical and experimental methods to verify the molecular design, the form and nature of the crystalline packing and the interactions with matrix materials in a practical composite system. Scientifically, this program will establish the foundation upon which the molecular design, the nature of crystal structure and the interactions with matrix materials in composite systems are combined to design energetic ingredients resistant to thermal or shock loading conditions. The program will provide a potential replacement of one or more of today's energetic ingredients solving the requirement for an insensitive high performance energetic material for combat safe military applications.

The fundamental challenge of this topic is directed toward the synthesis of new insensitive energetic ingredients, which can only be achieved through a fundamental understanding of the underlying molecular and crystalline structural properties and the advancement of the detonation physics based models used to optimize insensitive properties associated with specific molecular and crystalline arrangements. The program will provide new ingredients with the appropriate structural criteria solving long standing issues of sensitivity and performance. The initial working hypotheses, noted below, provide an empirical foundation upon which proposed research efforts will be measured against. Empirical hypotheses include:

- A. **Increase Hydrogen Bonding:** Impart high levels of hydrogen bonding to the molecules to increase the heat capacity of the compounds. This should allow the materials to dissipate the heat in a manner other than breaking bonds and consequently detonating.
- B. **Delocalize Electron Density in Nitro Groups:** Design compounds in which the electron density is spread from the nitro groups to surrounding groups. This increases bond order between the nitro group and the atom to which it is bound; the resulting charge distribution should render the molecule more stable.
- C. **Utilize Coulombic Attractions to Stabilize the Ground-State Structure:** Stabilize the ground-state geometry by designing structures whose sigma or pi framework have alternating positive and negative charges.

- D. **Reduce the Number of Nitro Groups:** Impart stability to these molecules, by including energetic oxygen functionality in groups other than nitro groups, such as N-Oxides.
- E. **Avoid High Acidity:** High acidity reduces the formulation compatibility of an explosive; measures to avoid high acidity such as using imidazole rings and aminating to block hydrogen should be explored.
- F. **Maximize Crystal Packing Planarity:** Design compounds with linear planar two dimensional atomic arrangements to minimize slip plane resistance to shock and shear ignition mechanisms.
- G. **Carbon Monoxide Oxygen Balance:** the new materials should strive for zero CO oxygen balanced, a goal for all mono-propellant applications and which currently exists for our most effective explosive ingredients (RDX and HMX).

When the above hypotheses are coupled with the very logical and often economic synthesis pathways, this topic becomes extremely attractive. All of the above criteria have emerged over the past 30 years of synthesis and molecular dynamics research as well as advances in our understanding of the criteria that govern energetic material initiation, growth and propagation. Proposal must focus and capitalize on our understanding that couples the molecular and structural nature of ingredients to their inherent sensitivity and performance.

b. Propulsion (AP Replacement, SRM-Based, New Polymers)

In order to further explore this technical area of energy per volume, safety, and affordability authors are invited to present related work and on-going research activities associated with:

- A. The fundamental understanding of new molecular design for High Energy Dense Oxidizer (HEDO) synthesis research
- B. New revolutionary advanced energetic oxidizers molecules:
 - i. Density (2 g/cc)
 - ii. Oxygen content greater than ammonium perchlorate (AP)
 - iii. Melting point greater than 150⁰ C
 - iv. Minimum number of synthesis steps
 - v. Sensitivities no worse than RDX/HMX
 - vi. Low hydrogen and carbon; high oxygen and nitrogen content
 - vii. High positive enthalpy
 - viii. Economic or bulk starting materials
- C. Improvements in ab initio determination of crystal structures, heats of formation, and density prediction models
- D. Understanding of topological electron density of energetic molecular crystals to assist target molecule design and selection
- E. Many of the hypotheses provided above (for the design and synthesis of energetic ingredients) also apply to this research area.

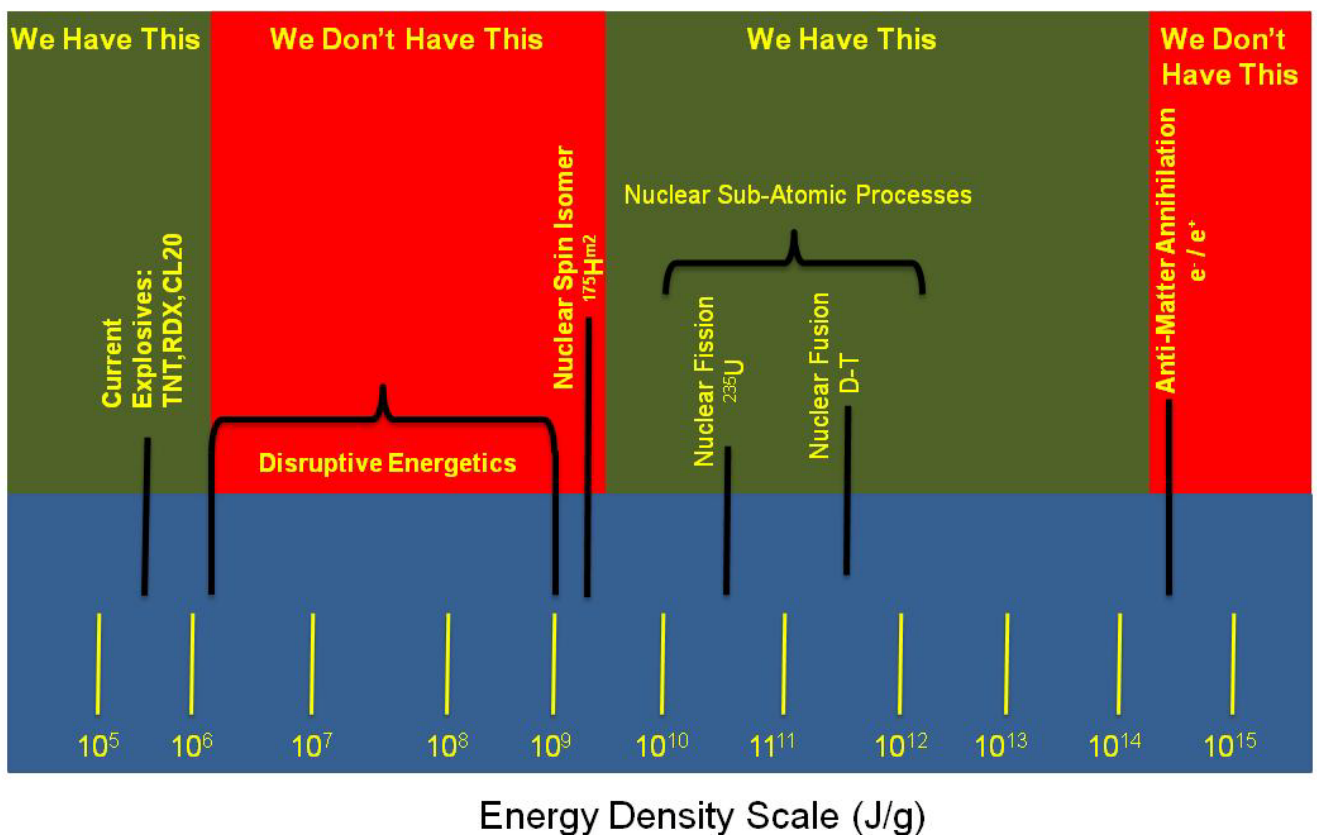
c. Reactive Materials

In recent years, ONR has been investigating the ability of advanced reactive materials to dramatically enhance ordnance capabilities of current and future Navy weapons. The lethal attributes of reactive materials can enable significant improvements to warhead concepts to enhance effectiveness when engaging both air and ground targets. Reactive material enhanced weapons offer the potential of smaller and lighter ordnance while maintaining equal or greater effectiveness. These materials are enablers for advanced weapons concepts that are adaptable, or multi-mission, in terms of target lethality. Reactive materials enhanced ordnance concepts are sought to demonstrate these capabilities based on the following objectives:

- E. Candidate reactive materials that results in a theoretical density of 13g/cc (Threshold) and 15 g/cc (Objective).
- F. Energy release from these fragments should have a theoretical value of greater than 1000 calorie/gram.
- G. Advanced formulations that consist of heavy metals, metal/metal, metal/metal oxide composites that demonstrate suitability for use in fragmentation under extreme pressure conditions, such as those in a detonation.
- H. Identify relevant reactive materials formulations of interest to the DoD and the key material properties that are linked to high density, survive explosive launch, pulverize upon target impact and have sufficient strength to survive normal operational logistics.

d. Disruptive Technology (Coulombic Explosion, Cluster Materials)

In order to remain ahead of the changing face of warfare the DoD must continue to explore disruptive technologies or energy enhancements which provide an asymmetrical advantage to the warfighter. The US Navy is continuously looking toward future technologies that provide a revolutionary advancement in defense systems as well as those technologies that will provide an asymmetrical advantage on the battlefield. ONR is currently seeking information on technologies such as Coulombic Explosions, Cluster Materials or other non-traditional potential energy sources that bridge the gap between molecular orbital bonding energy and nuclear fission or fusion energy outputs, figure 1.



Energy Density Scale For Current And Potential Energy Sources; Disruptive Energetics Would Fill The Energy Gap Between Conventional Explosive And Nuclear Events

Figure 1

In order to further explore this technical area authors are invited to present related work and on-going research activities associated with:

- A. Modeling and Simulations to predict concept dynamics, accounting for electron-electron, electron-ion, ion-ion interactions and alternate energy sources.
- B. Experimentation and validation of theoretical concepts.

C. Diagnostics to provide an understanding of the deviations between theoretical and experimental data.

Schedule

Task	Septemebr 19-30	October 3-28	October 31- Dec 2	Dec 5 - Dec 30	Jan 2- 27	Mar
Develop Special Notice	█					
Review & Release Special Notice		15 Oct █				
White Papers Due			7 Nov █			
White Paper Review and Down Select for Request for Full Proposal				21 Nov █		
Request for Full Proposals					23 Dec █	
Review & Down Select Proposals						14 Jan █
Contract Award(s)						█

Responses are DUE not later than 5pm (EST) **November 07, 2011**

III. WHITE PAPER SUBMISSION

White papers should not exceed 4 single-sided pages, exclusive of cover page and resume of principal investigator, and should be in 12-point Times New Roman font with margins not less than one inch. The cover page should be labeled “White Paper for 2011 Research Opportunity: Energetic Materials Program” and include the following information: title of the proposed effort, technical point of contact, telephone number, fax numbers, and e-mail address. The 4-page body of the white paper should include the following information: (1) Principal Investigator; (2) Relevance of the proposed effort to the research areas described in Section II; (3) Technical objective of the proposed effort; (4) Technical approach that will be pursued to meet the objective; (5) A summary of recent relevant technical breakthroughs; and (6) A funding plan showing requested funding per fiscal year. A resume of the principal investigator, not to exceed 1 page, should also be included after the 4-page body of the white paper.

Although not required, white papers are strongly encouraged for all offerors seeking funding. Each white paper will be evaluated by the Government to determine whether the technology advancement proposed appears to be of particular value to the Department of the Navy. Initial Government evaluations and feedback will be issued via e-mail notification from the Technical Point of Contact. The initial white paper appraisal is intended to give entities a sense of whether their concepts are likely to be funded.

Detailed Full Proposal (Technical and Cost volumes) will be subsequently encouraged from those Offerors whose proposed technologies have been identified through the above referenced e-mail as being of “particular value” to the Government. However, any such encouragement does not assure a subsequent award. Full Proposals may also be submitted by any offeror whose white paper was not identified as being of particular value to the Government or any offeror who did not submit a white paper.

For white papers that propose efforts that are considered of particular value to the Navy but either exceed available budgets or contain certain tasks or applications that are not desired by the Navy, ONR may suggest a full proposal with reduced effort to fit within expected available budgets or an effort that refocuses the tasks or application of the technology to maximize the benefit to the Navy. White papers should be submitted electronically to the program technical points of contact, Dr. Clifford Bedford (clifford.bedford@navy.mil), with cc to Michael Glick (Michael.glick.ctr@navy.mil). These white papers shall be in Microsoft Word or Adobe PDF format.

To ensure full, timely consideration for funding, white papers should be submitted **no later than November 07, 2011**. White papers received after that date will be considered as time and availability of funding permit.

The planned date for completing the review of white papers is **December 2, 2011**.

V. FULL PROPOSAL SUBMISSION AND AWARD INFORMATION

Full proposals (including one technical volume and one cost volume) should be submitted under **ONR BAA12-001** by **23 Dec 2011**. Full Proposals received after that date will be considered as time and availability of funding permit.

ONR anticipates that both grants and contracts will be issued for this effort. Full proposals for contracts should be submitted in accordance with the instructions at Section IV, Application and Submission Information, item 2.b, Full Proposals. Full proposals for grants should be submitted in accordance with the instructions at Section IV, Application and Submission Information, item 5, Submission of Grant Proposals through Grants.gov. All full proposals for grants must be submitted through www.grants.gov. The following information must be completed as follows in the SF 424 to ensure that the application is directed to the correct individual for review: Block 4a, Federal Identifier: Enter N00014; Block 4b, Agency Routing Number, Enter the three (3) digit Program Office Code 351 and the Program Officer's name, last name first, in brackets (Bedford, Clifford). All attachments to the application should also include this identifier to ensure the proposal and its attachments are received by the appropriate Program Office.

VI. SIGNIFICANT DATES *

Event	Date
White Paper Submission Date	07 Nov 2011
Notification of White Paper Evaluation	2 Dec 2011
Full Proposal Submission Date	23 Dec 2011
Notification of Selection: Full Proposals	14 Jan 2012
Awards	14 May 2012

Note: * These are approximate dates.

VII. POINTS OF CONTACT

The specific points of contact for this announcement are listed below:

Technical Points of Contact:

Dr. Clifford Bedford, Program Officer (clifford.bedford@navy.mil),
with cc to Michael Glick (Michael.glick.ctr@navy.mil)

Business Point of Contact:

Joe Cloft, Contracting Officer (joseph.cloft@navy.mil)

VIII. Submission of Questions

Any questions regarding this announcement must be provided to the Technical Points of Contact and/or the Business Point of Contact listed above. All questions shall be submitted in writing by electronic mail.

Answers to questions submitted in response to this Special Notice will be addressed in the form of an Amendment and will be posted to the following web page:

- Federal Business Opportunities (FEDBIZOPPS) Webpage – <https://www.fbo.gov/>
- Grants.gov Webpage – <http://www.grants.gov/>
- ONR Broad Agency Announcement (BAA) Webpage - <http://www.onr.navy.mil/en/Contracts-Grants/Funding-Opportunities/Broad-Agency-Announcements.aspx>

Questions regarding **White Papers or Full Proposals** should be submitted two weeks before the date and time for receipt of White Papers or Full Proposals. Questions after this date may not be answered, and the date for submission of the white papers/full proposals may not be extended.