# DEFENSE THREAT REDUCTION AGENCY

# BROAD AGENCY ANNOUNCEMENT

# HDTRA1-11-16-BRCWMD-BAA

## Research and Development Enterprise

### Basic and Applied Sciences Directorate

### Basic Research for

### Combating Weapons of Mass Destruction (C-WMD)

## March 2011

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## OVERVIEW INFORMATION

1. Federal Agency Name:

   Defense Threat Reduction Agency (DTRA)
   Research and Development (R&D) Enterprise
   Basic and Applied Sciences Directorate
   8725 John J. Kingman Road
   MS 6201
   Fort Belvoir, VA 22060-6201

2. Funding Opportunity Title:

   FY2011 – 2016 Basic Research for Combating Weapons of Mass Destruction (C-WMD) Broad Agency Announcement (BAA)

3. Announcement Type:

   This BAA, which is in effect from March 2011 through September 2016, establishes the multi-year process and serves as the announcement for the first round of submissions (referred to as "periods").

   Over this timeframe there will be multiple opportunities/periods to electronically submit research ideas. Each period will have a two-phased submission process. *Phase I* is the pre-application white paper submission, and open to all qualified entities; *Phase II* is an invitation-only full proposal submission resulting from Phase I pre-application white paper review as decided by the DTRA Selection Authority.

4. Funding Opportunity Number:

   HDTRA1-11-16-BRCWMD-BAA

5. Catalog of Federal Domestic Assistance (CFDA) Number:

   12.351

6. Dates:

   This BAA will have multiple, consecutive opportunities/periods which are not predetermined; however, it is anticipated that there will be at least one opportunity for each year announced in the December timeframe; there may be additional opportunities/periods in any year. Subsequent submission opportunities/periods with corresponding topics, application packages, applicable deadlines, will be published via amendments to this BAA.

   The Phase I (pre-application white paper) and Phase II (invitation-only proposal) submission deadlines are/will be shown in Table 1 (below and in Section IV.3.3). The Tables will be updated (by amendments to this BAA) as changes are made to the schedule.

All submissions (pre-application white papers and invited proposals) must be made in accordance with the submission instructions in this BAA through Grants.gov using the application packages provided with this BAA. Applicants are responsible for ensuring compliant and final submission of their Phase I pre-application white papers and Phase II applications. Any submission that does not conform to the requirements outlined in the BAA and in the invitation for proposal may not be reviewed or considered further.

| Date | Event |
|---|---|
| 1 March 2011 | BAA announced on Grants.gov |
| ***Period A*** | |
| 2:00 PM EST,<br>8 April 2011 | Phase I pre-application white paper receipt deadline |
| 2:00 PM EST,<br>Not prior to 18 May 2011 and<br>Not later than 13 June 2011* | Phase II invitation-only proposal receipt deadline<br>* The exact due date and time for the full proposals will be provided in the letters of invitation. |
| September 2011—March 2012 | Period A Grants scheduled to be awarded |
| ***Period B*** | |
| TBD | Amendment to the BAA announced on Grants.gov with Period B topics, application packages, and applicable deadlines |
| TBD | Phase I pre-application white paper receipt deadline |
| TBD | Phase II invitation-only proposal receipt deadline |
| TBD | Period B Grants scheduled to be awarded |
| ***Period C*** | |
| TBD | Amendment to the BAA announced on Grants.gov with Period C topics, application packages, and applicable deadlines |
| TBD | Phase I pre-application white paper receipt deadline |
| TBD | Phase II invitation-only proposal receipt deadline |
| TBD | Period C Grants scheduled to be awarded |
| ***Period D*** | |
| ***Period E*** | |
| ***Period F*** | |
| ***Period G*** | |

| |
|---|
| ….. |
| ***Period 'n'*** |

Table 1: List of important dates

## ADDITIONAL OVERVIEW CONTENT

This BAA is focused on soliciting **basic research** projects that support the DTRA mission to safeguard America and its allies from WMD (e.g., chemical, biological, radiological, nuclear, and high-yield explosives) by providing capabilities to reduce, eliminate, and counter the threat and mitigate its effects. To this end, DTRA seeks research across broad strategic thrust areas:

- ***Science of WMD Sensing and Recognition***
- ***Cognitive and Information Science***
- ***Science for Protection***
- ***Science to Defeat WMD***
- ***Science to Secure WMD***

Detailed descriptions of these thrust areas can be found in Section I.3. The specific research opportunities (topics) for each period that align to these thrust areas are listed in Section VIII. Research topics are only valid for the submission period in which they are posted, and only pre-application white papers responsive to the topics posted for a given submission period will be considered.

Resulting awards from this announcement will be **grants only**. These grants will be paid using a fixed, bi-annual invoice schedule; under no circumstances will these grants allow invoice of actual costs incurred.

## I. FUNDING OPPORTUNITY DESCRIPTION

I.1. This BAA is an extramural endeavor that combines basic research needs of DTRA and the Joint Science and Technology Office for Chemical and Biological Defense (JSTO-CBD) to address the full spectrum of counter-WMD challenges. Both DTRA and JSTO-CBD share the mission to safeguard America and its allies from WMD and provide capabilities to reduce, eliminate, and counter the threat and effects from chemical, biological, radiological, nuclear, and high-yield explosives. Each seeks to identify, adopt, and adapt emerging and revolutionary sciences that may demonstrate high payoff potential to counter-WMD threats.

I.2. This announcement solicits pre-application white papers for long-term challenges in specific fundamental areas of basic research that offer a significant contribution to the current body of knowledge or further the understanding of phenomena and observable facts and may have impact on future capabilities that support the DTRA and JSTO-CBD missions. Responses to this BAA must address **only basic research**. Pre-application white paper and proposal submissions that address applied research, advanced technology development, or combine basic research with applied research and/or advanced technology development will be considered not responsive and will not be evaluated further.

I.2.1. Basic research is the systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind. It includes all scientific study and experimentation directed toward increasing fundamental knowledge and understanding in those fields of the physical, engineering, environmental, and life sciences related to long-term national security needs. It is farsighted, high payoff research that provides the basis for technological programs.[1]

I.2.2. In contrast to basic research, applied research is the systematic study to understand the means to meet a recognized and specific need. It is a systematic expansion and application of knowledge to develop useful materials, devices, and systems or methods. The boundary between basic research and applied research occurs at the point when sufficient knowledge exists to support a hypothesis involving a specific application.[2]

I.3. DTRA seeks unclassified basic research across five major functional counter-WMD research thrust areas. Specific research topics that align to one or more thrust areas are presented in Section VIII. The five thrust area descriptions are outlined below.

- ***Thrust Area 1—Science of WMD Sensing and Recognition:*** The basic science of WMD sensing and recognition is the fundamental understanding of materials that demonstrate measurable changes when stimulated by energy, molecules, or particles from WMD in the environment. This research thrust involves exploration and exploitation of

[1] DoDI 3210.1, September 16, 2005

[2] DoD Financial Management Regulation Volume 2B, Chapter 5

interactions between materials and various electromagnetic frequencies, molecules, nuclear radiation or particles. These interactions and the specific form of recognition they provide are used for subsequent generation of information that provides knowledge of the presence, identity, and/or quantity of material or energy in the environment that may be significant.

- ***Thrust Area 2—Cognitive and Information Science:*** The basic science of cognitive and information science is the convergence of computer, information, mathematical, networks, natural, and social science. This research thrust expands our understanding of social networks and advances knowledge of adversarial intent with respect to the acquisition, proliferation, and potential use of WMD. The methods may include analytical, computational or numerical, or experimental means to integrate knowledge across disciplines and improve rapid processing of intelligence and dissemination of information.
- ***Thrust Area 3—Science for Protection:*** Basic science for protection involves advancing knowledge to protect life and life-sustaining resources and networks. Protection includes threat containment, decontamination, threat filtering, and shielding of systems. The concept is generalized to include fundamental investigations that reduce consequences of WMD, assist in the restoration of life-sustaining functions, and support forensic science.
- ***Thrust Area 4—Science to Defeat WMD:*** Basic science to defeat WMD involves furthering the understanding of explosives, their detonation, and problems associated with accessing target WMDs. This research thrust includes the creation of new energetic materials or physical approaches that enhance the defeat of WMDs by orders of magnitude, the improvement of modeling and simulation of these materials and various phenomena that affect success and estimate the impact (lethality) of defeat actions, including the assessment of event characteristics using various dynamic analytical methods.
- ***Thrust Area 5—Science to Secure WMD:*** Basic science to support securing WMD includes: (a) environmentally responsible innovative processes to neutralize chemical, biological, radiological, nuclear, or explosive (CBRNE) materials and components; (b) discovery of revolutionary means to secure components and weapons; and (c) studies of scientific principles that lead to novel physical or other tags and methods to monitor compliance and disrupt proliferation pathways. The identification of basic phenomena that provide verifiable controls on materials and systems also helps arms control.

I.4. DTRA seeks unclassified basic research ideas that are responsive to the goals and objectives of the topics outlined in Section VIII. The topics labeled "PerA" are only valid for Period A of this BAA. Only pre-application white papers responsive to the topics posted for Period A and submitted by the Period A deadline will be considered. A new list of topics will be posted for subsequent periods with corresponding pre-application white paper due dates.

## II. AWARD INFORMATION

II.1. Resulting awards from this BAA will be **grants only**. These grants will be paid using a fixed, bi-annual invoice schedule; under no circumstances will these grants allow invoice of actual costs incurred.

II.2. The final number of grants and the amount of funds allocated for each period will be determined after all pre-application white papers and invited proposals are received and evaluated. On average DTRA expects to award 50-75 grants annually for a total grant value of approximately $66M.

II.3. The Government actions under this BAA shall adhere to the requirements of the Department of Defense (DoD) Grant and Agreement Regulations (DoDGARs). DoDGARs can be accessed online at http://www.dtic.mil/whs/directives/corres/html/321006r.htm. See also 32 Code of Federal Regulations (CFR) 22, which can be accessed online at http://ecfr.gpoaccess.gov/.

II.4. There are four (4) categories of awards, which are detailed below. The applicant does not need to specify the type of award sought. It will be inferred by the dollar amount requested and/or the topic to which the pre-application white paper is submitted.

1. Single Scope Awards: Research projects that focus on exploratory aspects of a unique problem, a high-risk approach, or innovative research in subjects with potential for high impact to C-WMD science. Research must support undergraduate and/or graduate students.

   Single Scope Awards may have Co-Principal Investigators (Co-PIs), subawards (grants and/or contracts). Single Scope Awards will be made by a single grant to the lead organization. Subawards, including all grants and contracts, are the responsibility of the award recipient; exceptions will not be made.

   Single Scope Awards will average $150K per year for DTRA sponsored topics and $250K per year for JSTO-CBD Program sponsored topics. Single Scope Awards may have a period of performance (POP) of up to five (5) years. Awards are typically for a base period of three (3) years with two (2) additional years as possible options. Proposals that outline scope and effort for a three (3) year base period and do not propose options are also acceptable.

   The predominance of awards will be Single Scope Awards.

2. Multidisciplinary Awards: Research projects that involve a comprehensive program of innovative research in an interdisciplinary area with potential for high impact. The proposed research must involve fundamental contributions in research by multiple investigators from diverse disciplines (proposal **must** be multidisciplinary). Investigators may be from a single institution or multiple institutions. Research must support multiple undergraduate and/or graduate students.

Authors of these pre-application white papers and invited proposals must take great care to clearly outline the impact to C-WMD science that is to be gained from the higher dollar amount investment and justify the scientific contribution from each investigator.

Proposals submitted under this category must have a single lead organization and single submission for the pre-application white paper and the invited proposal. Multidisciplinary Awards will be made by a single grant to the lead institution. Subawards, including all grants and/or contracts, are the responsibility of the award recipient; exceptions will not be made.

Multidisciplinary Awards will average $350K per year for DTRA sponsored topics and $500K per year for JSTO-CBD Program sponsored topics. Multidisciplinary Awards may have a POP of up to five (5) years. Awards are typically for a base period of three (3) years with two (2) additional years as possible options. Proposals that outline scope and effort for a three (3) year base period and do not propose options are also acceptable.

3. Young Investigator Awards: Research projects that focus on exploratory aspects of a unique problem, a high-risk approach, or innovative research in subjects with potential for high impact to C-WMD science from individuals currently employed by a U.S. accredited degree-granting college or university who received a Ph.D. or equivalent degree within five (5) years of the date of the pre-application white paper submission.

   Young Investigator Awards may have subawards; however, subawards that transfer substantive programmatic activity will be considered non-responsive to the Young Investigator topics. Young Investigator Awards will be made by a single grant to the lead organization. Subawards, including all grants and/or contracts, are the responsibility of the award recipient; exceptions will not be made.

   Young Investigator Awards will average $100K per year and may have a POP of up to two (2) years. Young Investigator Awards may not include option years.

4. Seed Awards: Research projects that focus on the exploratory aspects of a research hypothesis or on the development of a high-risk approach with potential for high impact to C-WMD science.

   Seed Awards may have Co-PIs and subawards. Seed Awards will be made by a single grant to the lead organization. Subawards, including all grants and/or contracts, are the responsibility of award recipient; exceptions will not be made.

   Seed awards will be less than $75K and will typically have a POP of one (1) year or less. Seed Awards may not include option years.

II.5. Funding for participation in this program is highly competitive and the cost of proposed research should strictly be maintained in the award amounts outlined for each award type and for each topic. Under no circumstances will awards exceed 10% of the averages as outlined for each award type and for each topic. Exceptions will not be made.

II.6. Subawards (grants and/or contracts) are permitted. Subawards may be used to carry out a portion of the research. In instances where the lead applicant is an accredited degree-granting college and/or university, applicants should note that substantive programmatic activity must be maintained at accredited degree-granting colleges and universities. DTRA will review and consider the proposed subawards for all pre-application white papers and proposals on a case-by-case basis.

II.7. Applications for renewal or supplementation of existing DTRA funded projects are not eligible to compete with applications for new awards.

II.8. The Government will not provide any hardware or software to execute the proposed research. Exceptions will not be made.

II.9. The Government reserves the right to fund all, some, or none of the proposals submitted; may elect to fund only part of any or all proposals; and may incrementally or fully fund any or all awards under this BAA. All awards are subject to the availability of funds.

## III. ELIGIBILITY INFORMATION

III.1. Pre-application white papers and proposals submitted for this BAA will be considered from the following U.S. and foreign-based equivalents:

- Accredited degree-granting colleges and universities.
- Industrial/commercial basic research centers, including small businesses with a portfolio predominantly in basic research proposing a project with significant participation (minimum 30% of total effort value on the proposed project) by one or more accredited degree-granting colleges and/or universities. Note: Not eligible for Young Investigator Awards.
- Not-for-profit organizations/basic research centers with a portfolio predominantly in basic research proposing a project with significant participation (minimum 30% of total effort value on the proposed project) by one or more accredited degree-granting colleges and/or universities. Proof of 501(c)(3) status from the Internal Revenue Service may be required. For foreign-based establishments entirely based outside the U.S. and/or its territories, proof of not-for-profit status may be required. Note: Not eligible for Young Investigator Awards.

III.2. The following entities may not participate as prime grantees for awards made under this BAA, but may act as collaborators, including as Co-PIs, and/or subawardees:

- Federal laboratories (including DoD and Department of Energy (DOE)[3] laboratories), academic institutions, agencies, and organizations.
- DoD-sponsored Federally Funded Research and Development Centers (FFRDCs) specified in the Defense Federal Acquisition Regulation Supplement (DFARS) 235.017-1: http://farsite.hill.af.mil/VFDFARA.HTM and click on 'DFARS Part 35'.
- DOE-sponsored FFRDCs[4].
- Foreign government-owned institutions.
- Industrial/commercial firms other than those outlined in Section III.1.

Note: DoD degree-granting academic institutions that are Federal government organizations, e.g. United States Military Academy at West Point, The Air Force Institute of Technology, etc., are eligible to submit pre-application white papers and proposals in response to the intramural Service Call issued by the DTRA Basic Research and Applied Sciences Directorate, see http://www.dtrasubmission.net and follow the link to the 'FY11-16 Basic Research for Combating Weapons of Mass Destruction (WMD) Service Call for DoD Degree-Granting Academic Institutions'. Please note that the Service Call link will also contain the submission periods. Eligibility requirements under the Service Call are subject to change.

III.3. Cost sharing and/or matching is not required.

III.4. Other.

III.4.1. DTRA uses the Excluded Parties List System (EPLS) to exclude recipients ineligible to receive Federal awards. EPLS can be accessed online at http://epls.arnet.gov (Reference 2 CFR 1125).

III.4.2. There is no limit on the number of pre-application white papers and invited proposals that an applicant (PI/Co-PIs) may submit in response to this BAA.

III.4.2.1. Applicants (PI/Co-PIs) may submit pre-application white papers and invited proposals to one or more topics.

III.4.2.2. Applicants (PI/Co-PIs) may submit pre-application white papers and invited proposals to one or more periods under this BAA, regardless of a previous submission's disposition.

III.4.2.3. Applicants (PI/Co-PIs) are **strongly** encouraged to minimize overlap in scope and level of effort if multiple projects are submitted for pre-application white papers and invited proposals. Further, individual PIs and Co-PIs are discouraged from repackaging research and submitting multiple redundant Phase I submissions in any given period of this BAA.

[3] DOE-sponsored laboratories must obtain authorization from the DOE sponsor. DTRA does not require documentation of this authorization.

[4] DOE-sponsored FFRDCs must obtain authorization from the DOE sponsor. DTRA does not require documentation of this authorization.

## IV. APPLICATION AND SUBMISSION INFORMATION

IV.1. Address to Request Application Package.

IV.1.1. This announcement contains all information required to submit a pre-application white paper and invited proposal.

IV.1.2. For convenience, Microsoft (MS) Word and MS PowerPoint templates are provided on the www.dtrasubmission.net/portal for applicant use, as noted in the text of this announcement. Applicants are encouraged to use the templates for preparing submissions; however, use of the templates is not required.

IV.1.3. The required application packages for the pre-application white papers are provided with this announcement. Note that each topic outlined in Section VIII has a unique application package posted with this BAA. **The application package corresponding to the topic of interest must be used for submission of pre-application white papers.**

IV.1.4. The required application packages for the invited proposals will be posted at a later date. As with the Phase I submissions, each topic outlined in Section VIII will have a unique application package**. The application package corresponding to the topic of interest must be used for submission of invited proposals.** Application packages for Phase II submissions will be posted following the notification of invitation for proposals.

IV.1.5. Example application packages for both pre-application white papers and invited proposals are included with this posting. These example packages are for demonstration purposes only and must not be used to submit applications pursuant to this BAA. These packages are clearly noted with the Competition ID of "Example" and the Competition Title of "Phase I Example Pre-Application White Paper" and "Phase II Example Application," respectively.

IV.1.6. DTRA will not review any of the following:

- Pre-application white papers that attempt to address multiple topics.
- Pre-application white papers that are submitted to topics from previous periods.
- Application packages and proposals for Phase II submissions that were not invited.
- Application packages submitted using the Competition ID of "Example."

IV.1.7. The application packages posted to Grants.gov consist of the forms detailed in Table 2, which must be completed as part of the submission process. Additional files are required to be uploaded as attachments. Refer to Section IV.2.3 for more information on Phase I requirements and Section IV.2.4 for more information on Phase II requirements:

| Form Name | Phase I Pre-Application White | Phase II Invited Proposal |
|---|---|---|

| | | |
|---|---|---|
| SF-424 (R&R) Application for Federal Assistance Form | Required | Required |
| Research & Related Budget Form | N/A | Required |
| R&R Subaward Budget (Fed/Non-Fed) Attachment(s) Form(s) | N/A | If Applicable |
| Research & Related Senior/Key Person Profile Form | N/A | Required |
| Research & Related Other Project Information Form | N/A | Required |
| Attachments Form | N/A | Required |

Table 2: Forms. The instructions for completing each of these forms may be found online at the following web link: http://www07.grants.gov/agencies/forms_instruction_information.jsp.

IV.2. Content and Form of Application Submission. Each period of this BAA will be conducted in two phases. Phase I is for receipt of pre-application white papers. Phase II is for receipt of invited proposal applications. Invitation to the Phase II, invited proposal submission, will be based on the evaluation results of the Phase I pre-application white paper.

IV.2.1. Pre-application white papers and invited proposals must be submitted electronically using Grants.gov and the corresponding application packages provided with this BAA on Grants.gov.

IV.2.2. Applicants are responsible for ensuring compliant and final submission of their Phase I pre-application white paper and Phase II invited proposal application. Any submission that does not conform to the requirements outlined in the BAA and in the invitation for proposal may not be reviewed or considered further.

IV.2.3. **Phase I Pre-Application White Paper Submission and Content.**

IV.2.3.1. Each pre-application white paper must address only one of the research topics detailed in Section VIII for the *relevant period*. Each pre-application white paper must use the application package for the specific topic number as presented in Section VIII of this BAA.

IV.2.3.2. Each Phase I application package contains the following form (Note: all other BAA guidelines must also be met to be considered a true complete package):

| Form (Section in the BAA) | Attachment | Action |
|---|---|---|
| SF-424 (R&R) Application for Federal Assistance Form (IV.2.4.2.1) | Up to four (4) page white paper. | Enter the appropriate information in data fields |

Table 3: Phase I Pre-Application White Paper Package Chart.

IV.2.3.2.1 Each Phase I application package contains the **SF 424 (R&R) Application for Federal Assistance**. To be considered a complete package, an up to four (4) page white paper is required to be uploaded as an attachment to the SF 424 (R&R) (Note: all other BAA guidelines must also be met to be considered a true complete package). DTRA-specific instructions for completing the SF 424 (R&R) Application for Federal Assistance are below, general application instructions can be found on Grants.gov:

- **Block 1 – Type of Submission.** Applicants should indicate the Phase I submission is a "Pre-Application."
- **Block 2.1 – Applicant Identifier.** Not applicable.
- **Block 3 – Date Received by State.** Not applicable.
- **Block 3.1 – State Application Identifier.** Not applicable.
- **Block 5 – Applicant Information.** You must provide a Business Office Point of Contact (BPOC) with an e-mail address.
- **Block 19 – Authorized Representative.** The "signature of AOR" is not an actual signature and is automatically completed upon submission of the electronic application package. ***Hard copies of applications will not be accepted.***
- **Block 20 – Pre-application.** Should be used to attach an up to four (4) page white paper. The white paper itself should provide sufficient information on the research being proposed (e.g., the hypothesis, theories, concepts, approaches, data measurements, and analysis, etc.) to allow for an assessment by a technical expert.

  Any pages submitted for the white paper that exceed the limit of four pages will not be read or evaluated. A page is defined as 8 1/2 x 11 inches, single-spaced, with one-inch margins in type not smaller than 12 point Times New Roman font. The white paper must be provided in portrait layout.

  At minimum, the white paper should address the following:

  - A project abstract, which should be concise (less than 250 words), provide a summary of the proposed work, and demonstrate relevance to the topic being addressed. The abstract should not contain any proprietary data or markings.
  - Potential scientific impact to provide greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts, including how the research contributes to the C-WMD science needs outlined in the topic.
  - The impact of the research on C-WMD science must be clearly delineated.

- Cost estimate by year and total dollars required to accomplish the research as presented in the white paper (no details or breakout of costs is required).
- Potential team and management plan, including details on student involvement.
- Multidisciplinary white papers should carefully detail each of the institutions/departments involved and the contribution that will be made by each of the investigators.
- Do NOT include corporate or personnel qualifications, past experience, or any supplemental information with the white paper.
- The topic number and name should be included as a header on the white paper and in the text of the white paper.

IV.2.4. **Phase II - Invited Proposal Submission and Content.**

IV.2.4.1. Each invited proposal must address the research topic for the corresponding Period that was the subject of the corresponding pre-application white paper, as detailed in Section VIII. Each invited proposal must use the application package for the specific topic number as presented in Section VIII of this BAA.

IV.2.4.2. Each Phase II application package contains the following forms (Note: all other BAA guidelines must also be met to be considered a true complete package):

| Form (Section in the BAA) | Attachment | Action |
|---|---|---|
| SF-424 (R&R) Application for Federal Assistance Form (IV.2.4.2.1) | | Enter the appropriate information in data fields |
| | Disclosure of Lobbying Activities Standard Form-LLL (if applicable) | Attach to Block 18 SFLL or other Explanatory Documentation |
| Research & Related Budget Form (IV.2.4.2.2) | Budget Justification for entire performance period | Attach to Section K in budget period one |
| R&R Subaward Budget (Fed/Non-Fed) Attachment(s) Form *(if applicable)* (IV.2.4.2.3) | Individual subaward budgets | Attach a separate budget with justification for each subaward |
| Research & Related Senior/Key Person Profile Form (IV.2.4.2.4) | PI Biographical Sketch | Attach to Biographical Sketch field |
| | PI Current/Pending Support In MS Word format | Attach to Current & Pending Support field |
| | Key Personnel Biographical Sketches | Attach to Biographical Sketch field for each senior/key person |
| | Key Personnel Current/Pending Support | Attach to Current & Pending Support field for |

| | | |
|---|---|---|
| | | each senior/key person |
| Research & Related Other Project Information Form (IV.2.4.2.5) | Proposal Summary/ Abstract | Attach to Block 7 Project Summary/ Abstract |
| | Technical Proposal | Attach to Block 8 Project Narrative |
| Attachments Form (IV.2.4.2.6) | Attachment 1 – SOW | Upload as Attachment 1 |
| | Attachment 2 – Quad Chart | Upload as Attachment 2 |

Table 4: Phase II Proposal Package Chart.

IV.2.4.2.1 **SF 424 (R&R) Application for Federal Assistance.** DTRA-specific instructions for completing the SF 424 (R&R) are below, general application instructions can be found on Grants.gov:

- **Block 1 – Type of Submission.** Applicants should indicate the Phase II submission is an "Application."
- **Block 2.1 – Applicant Identifier.** Not applicable.
- **Block 3 – Date Received by State.** Not applicable.
- **Block 3.1 – State Application Identifier.** Not applicable.
- **Block 5 – Applicant Information.** You must provide a Business Office Point of Contact (BPOC) with an e-mail address.
- **Block 18 – SFLL or other Explanatory Documentation.** Disclosure of Lobbying Activities Standard Form-LLL. The Disclosure of Lobbying Activities Standard Form-LLL, if applicable, should be completed and uploaded.
- **Block 19 – Authorized Representative.** The "signature of AOR" is not an actual signature and is automatically completed upon submission of the electronic application package. ***Hard copies of applications will not be accepted.***

IV.2.4.2.2 **Research and Related Budget Form.** The Research and Related Budget Form provided as part of the application package for the Phase II submission should be filled out in entirety for each project year proposed. Applicants are responsible for ensuring appropriate, approved rates are used in their budget forms. Applicants should note that in accordance with 32 CFR 22.205(b), grants shall not provide for the payment of fee or profit to the recipient.

Applicants should plan and budget for travel to accommodate the two meetings outlined below:

- National Conferences/Workshops/Symposia: Applicants are strongly encouraged to attend a nationally recognized conference, workshop, or

symposium in the field of research each calendar year (1 at minimum). Research should be presented as soon as adequate data are available to support posters and presentations. Conferences/workshops/symposia should be attended by the PI and students supporting the research, as appropriate.

- Annual Technical Review: Applicants should plan to attend an annual technical program review meeting. For planning purposes the review will be for five days and will be held in Northern Virginia. DTRA encourages graduate students to attend the Annual Technical Review.

**Budget Justification**. Applicants are required to submit a budget justification. The budget justification should be prepared as outlined in the instructions for the Research and Related Budget and uploaded as an attachment to Section K "Budget Justification" of the Research and Related Budget Form. The budget justification does not have a page limit, but should include sufficiently detailed information for meaningful evaluation. In addition, the budget justification must specifically address subaward costs and type to include the portion of work to be subawarded with a supporting rationale. The budget justification must include **a statement discussing how the subawardee(s) was determined to be fair and reasonable**.

IV.2.4.2.3 **R&R Subaward Budget (Fed/Non-Fed) Attachment(s) Form (if applicable).** Detailed cost estimates and budget justifications are required for each proposed subaward. The cost estimate for the subawards should include sufficiently detailed information for meaningful evaluation, including labor rates and indirect cost rates.

IV.2.4.2.4 **Research and Related Senior/Key Person Profile Form.** The Research and Related Senior/Key Person Profile Form should be completed in its entirety for each of the PIs and Co-PIs on the project. The inclusion of additional personnel is at the discretion of the PI. A **biographical sketch** is required for each PI and Co-PI on the project. DTRA does not have a preference for the format of the biographical sketch; however, it should be limited to 1 page per person. The biographical sketch should be uploaded as an attachment to the corresponding field on the Research and Related Senior/Key Person Profile Form.

Additionally, a **statement of current and pending support** must be provided for each PI and Co-PI on the project. This statement should include a summary of the current and pending support of related work and requires all grants and contracts through which each PI and Co-PI is currently receiving or may potentially receive financial support to be disclosed.

IV.2.4.2.5 **Research and Related Other Project Information Form.**

- **Block 7 – Project Summary/Abstract.** The uploaded project abstract should be concise (less than 250 words) and provide a summary of the proposed work and demonstrate relevance to the topic being addressed. The abstract should not contain any proprietary data or markings.

- **Block 8 – Project Narrative.** The uploaded technical proposal must not exceed 20 pages (including references). If the proposal exceeds 20 pages, only the first 20 pages will be reviewed. A page is defined as 8 ½ x 11 inches, single-spaced, with one-inch margins in type not smaller than 12 point Times New Roman font. The technical proposal must be provided in portrait layout. A **template** for the technical proposal format may be found online at www.dtrasubmission.net/portal (MS Word format).

  The technical proposal must include the following components:

  - ***Abstract.***
  - ***Scope.***
    - ***Objective.*** A clear and concise objective of the proposed project.
    - ***Background.*** Provide the necessary technical and scientific background to support the scientific and/or technical merit of the proposed project.
    - ***Programmatics***. Describe your organization's management plan for the proposed project; list supporting and collaborating centers, and the roles/responsibilities of each identified academic and/or industrial subcontractor supporting the project. Authors of multidisciplinary proposals must take great care to clearly outline the impact to C-WMD science that is to be gained from the higher dollar amount investment and justify the scientific contribution from each investigator.
    - ***Relevance.*** Describe the relevance of the proposed project in terms of advancing the state of the science and the anticipated scientific impact on capabilities to potentially reduce, eliminate, counter, provide greater knowledge or understanding of the threat, and mitigate the effects of WMD fundamental aspects of phenomena and of observable facts.
  - ***Credentials.*** Describe the PI's qualifications and the organization's qualifications to perform the proposed work. Summarize the credentials of the primary performing center, and supporting academic and industrial partners to perform the work. Describe specific examples of equipment and/or facilities available to perform the proposed work. Focus on information directly relevant to the proposed work.
  - ***Work to be Performed.*** Provide details of the work to be performed by task and subtask. Tasks must be grouped by project year.
  - ***Performance Schedule.*** Provide a table of tasks and subtasks and the duration of performance of each in a Gantt or other suitably formatted chart.
  - ***References.*** List any relevant documents referenced.

IV.2.4.2.6 **Attachments Form.**

- **Attachment 1 – SOW.** The SOW does not have a page limit, but should be approximately 3-5 pages in length for incorporation into grant. The SOW should not contain any proprietary data or markings. Pages should be numbered and the initial page should have a date (document date) shown under the title (the title of the SOW should match that of the proposal). The SOW must be provided in portrait layout. A **template** for the SOW format may be found online at www.dtrasubmission.net/portal (MS Word format).

  The proposed SOW must accurately describe the research to be performed. The proposed SOW must also contain a summary description of the technical methodology as well as the task description, but not in so much detail as to make the SOW inflexible. The SOW format/guidance is as follows:

  - ***Objective:*** Brief overview of the specialty area. Describe why the research is being pursued and what knowledge is being sought.
  - ***Scope:*** Include a statement of what the SOW covers including the research area to be investigated, objectives/goals, and major milestones and schedule for the effort.
  - ***Background:*** The applicant must identify appropriate documents, including publications that are applicable to the research to be performed. This section includes any information, explanations, or constraints that are necessary in order to understand the hypothesis and scientific impact on capabilities needed to reduce, eliminate, and counter the threat, and also mitigate the effects of WMD. It may also include previously performed relevant research and preliminary data.
  - ***Tasks/Scientific Goals:*** This section contains the detailed description of tasks which represent the research to be performed that are contractually binding. Thus, this portion of the SOW should be developed in an orderly progression and presented in sufficient detail to establish the methodology and feasibility of accomplishing the overall program goals. The work effort should be segregated by performance period for all tasks to be performed and anticipated milestones realized in that year (e.g., Year 1, Year 2, etc, should be detailed separately). Identify the major tasks in separately numbered sub-paragraphs. Each major task should delineate, by subtask, the research to be performed by year and number each task using the decimal system (e.g., 4.1, 4.1.1, 4.1.1.1, 4.2, etc.). The sequence of performance of tasks and achievement of milestones must be presented by project year and task in the same sequence as in the Technical Proposal. The SOW must contain every task to be accomplished to include a detailed schedule.

    The tasks must be definite, realistic, and clearly stated. Use “the grantee shall” whenever the work statement expresses a provision that is binding. Use “should” or “may” whenever it is necessary to express a declaration

of purpose. Use active voice in describing work to be performed. Do not use acronyms or abbreviations without spelling out acronyms and abbreviations at the first use; place the abbreviation in parentheses immediately following a spelled-out phrase. If presentations/meetings are identified in your schedule, include the following statement in your SOW: "Conduct presentations/meetings at times and places specified in the grant schedule."

- **Attachment 2 – Quad Chart.** The quad chart must be presented on one (1) page. The quad chart must not contain any proprietary data or markings. The quad chart must be provided in landscape layout. A **template** for the quad chart format may be found online at www.dtrasubmission.net/portal (MS PowerPoint format). A pictorial representation of the quad chart is provided herein and includes the relevant fields that must be included in the Phase II proposal submission. The inclusion of the DTRA logo is not required. The quad chart should be uploaded as "Attachment 2" of the Attachments Form.

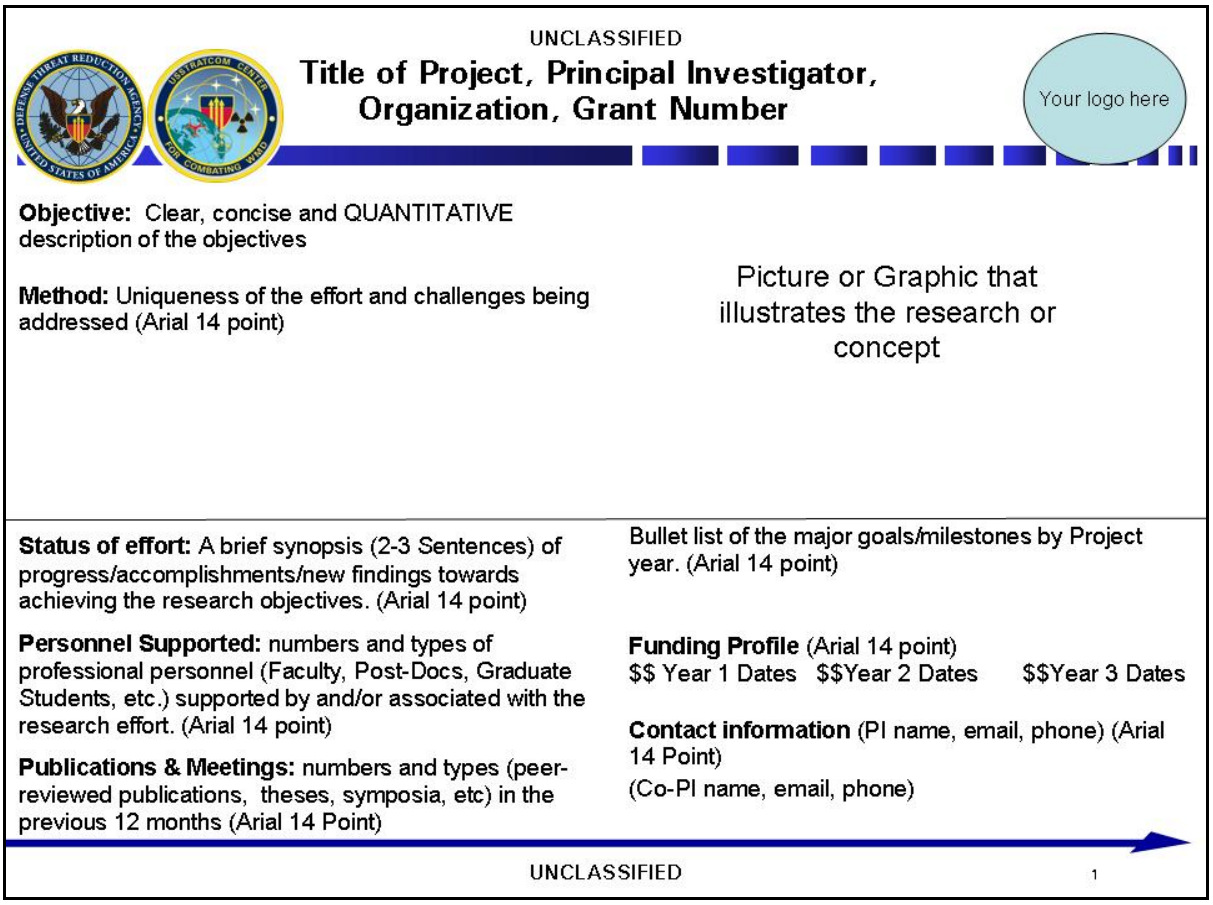


Figure 1: Sample Quad Chart.

IV.2.5. File Format.

IV.2.5.1. Perform a virus check before uploading any files to Grants.gov as part of your application package. If a virus is detected, it may cause rejection of the file.

IV.2.5.2. Do not lock or encrypt any files you upload to Grants.gov as part of your application package.

IV.2.5.3. Most documents should be uploaded as a Portable Document File (PDF) format. An exception to this is the quad chart (MS PowerPoint file compatible with the most recent version of MS PowerPoint) for the Phase II submission.

IV.2.5.4. Movie and sound file attachments will not be accepted.

IV.2.6. All submissions must be UNCLASSIFIED.

IV.3. Submission Dates and Times.

IV.3.1. Phase I pre-application white papers will be accepted based on periods as outlined in Table 5. A Phase II "receipt window" of 4 to 6 weeks will be provided in Table 5, however, the specific due dates for the Phase II invited proposal submissions will be provided in the letters of invitation. (The window is strictly for informational purposes only, to provide 'not prior to' and 'not later than' dates.) After the deadline date provided for a given period, the application packages will no longer be available for download from Grants.gov. Most importantly, applications will not be reviewed if they are received after these deadlines. Exceptions will not be considered.

IV.3.1.1. When sending electronic files, the applicant should allow for potential delays in file transfer from the originator's computer server to the Grants.gov website/computer server. Applicants are encouraged to submit their proposals early to avoid potential file transfer delays due to high demand encountered as the submission deadline approaches.

IV.3.1.2. Applicants are responsible for submitting pre-application white papers and invited proposals so as to be received by Grants.gov no later than the time and dates listed in Table 5 and the letter of invitation for proposals, respectively.

IV.3.1.3. Acceptable evidence to establish the time of receipt at the Government office includes documentary and electronic evidence of receipt maintained by DTRA. Applicants should also print, and maintain for their records, the electronic receipt following submission of a proposal to Grants.gov.

IV.3.1.4. Please note 15 U.S.C. 260a establishes daylight saving time as the standard time during the daylight saving period.

IV.3.2. Additional timeline details are available to all applicants at www.dtrasubmission.net/portal, e.g., estimated notification date for proposal invitations. Applicants are responsible for checking www.dtrasubmission.net/portal for changes and updates to the schedule.

IV.3.3. Additional opportunities for pre-application white paper submissions with applicable topics, due dates, and application packages will be posted as amendments to this BAA. Schedules of future amendments, topic information, and due dates will not be

provided and questions requesting information relevant to future amendments, schedules, and/or topics will not be answered in advance of an amendment.

| Date | Event |
|---|---|
| 1 March 2011 | BAA announced on Grants.gov |
| ***Period A*** | |
| 2:00 PM EST,<br>8 April 2011 | Phase I pre-application white paper receipt deadline |
| 2:00 PM EST,<br>Not prior to 18 May 2011 and<br>Not later than 13 June 2011* | Phase II invitation-only proposal receipt deadline<br>* The exact due date and time for the full proposals will be provided in the letters of invitation. |
| September 2011—March 2012 | Period A Grants scheduled to be awarded |
| ***Period B*** | |
| TBD | Amendment to the BAA announced on Grants.gov with Period B topics, application packages, and applicable deadlines |
| TBD | Phase I pre-application white paper receipt deadline |
| TBD | Phase II invitation-only proposal receipt deadline |
| TBD | Period B Grants scheduled to be awarded |
| ***Period C*** | |
| TBD | Amendment to the BAA announced on Grants.gov with Period C topics, application packages, and applicable deadlines |
| TBD | Phase I pre-application white paper receipt deadline |
| TBD | Phase II invitation-only proposal receipt deadline |
| TBD | Period C Grants scheduled to be awarded |
| ***Period D*** | |
| ***Period E*** | |
| ***Period F*** | |
| …… | |
| ***Period 'n'*** | |

Table 5: List of important dates. (Same as Table 1 located in the Overview Information)

IV.3.4. Late Submissions. If the application package and required attachments are submitted to Grants.gov after the exact time and date specified in this BAA for the pre-application white paper (Phase I) and/or the letter of invitation for the invited proposal (Phase II), the application is "late" and will not be considered. Exceptions will not be considered.

IV.3.5. Interruption of Government Processes. If an emergency or unanticipated event interrupts normal Government processes so that proposals cannot be submitted to Grants.gov by the exact time specified in this BAA for the pre-application white paper and/or the letter of invitation for the invited proposal, and urgent Government requirements preclude amendment of the BAA closing date, the time specified for receipt of applications will be deemed to be extended to the same time of day specified in the BAA on the first work day on which normal Government processes resume.

IV.4. Intergovernmental Review. Not Applicable.

IV.5. Funding Restrictions. Indirect costs may be restricted to less than 35% of the total grant value regardless of previously negotiated rates with the cognizant agency. The 2008 DoD Appropriations Act (Public Law 110-116, Section 8115), 2009 DoD Appropriations Act (Public Law 110-329, Section 8109), and the 2010 DoD Appropriations Act (Public Law 111-118, Section 8101) applied this restriction to awards made using fiscal year 2008, 2009, and 2010 Basic Research funds and **may** apply to future awards.

IV.6. Other Submission Requirements.

IV.6.1. Phase I and Phase II applications must be made through Grants.gov using the application package specific to the period/phase/topic of interest. Application packages for a *particular period* are posted with the announcement of the particular period (i.e., Period A is announced by the original posting of the BAA and the application packages are posted with it. When a new period is announced, an amendment will be published with new application packages). Applicants should take care to use the application package associated with the topic for which an application is being made.

Phase I and Phase II submissions made via any other means (e.g., hand-carried, postal service, commercial carrier, e-mail, etc.) will NOT be considered under any circumstances.

IV.6.2. Applicants should note that each organization must complete a one-time registration in order to submit its pre-application white paper(s) and application(s) through Grants.gov. Please see the following web link on information about registering with Grants.gov: http://www07.grants.gov/applicants/applicants.jsp. If your organization is already registered in Grants.gov, no further action should be required.

The registration process may take up to **four (4) weeks** to complete depending on your organization and requires multiple steps, some of which are detailed below.

- Identifying the Data Universal Number Systems (DUNS) number or registering for one with Dun & Bradstreet at http://fedgov.dnb.com/webform/displayHomePage.do if your organization does not have a DUNS number.
- Registering with the Central Contractor Registration (CCR) by calling the CCR Assistance Center at 1-866-606-8220, or you may register online at http://www.ccr.gov. You will NOT be able to complete your CCR registration until CCR has confirmed your Employer Identification Number (EIN) or Taxpayer Identification Number (TIN) with the Internal Revenue Service (IRS).

IV.6.3. All awards require certifications of compliance with Appendix A to 32 CFR 28 regarding lobbying. The full text of this certification is available at www.dtrasubmission.net/portal.

Proposers are certifying compliance with this regulation by submitting the invited proposal. It is not necessary to include the certification text with your invited proposal.

IV.6.4. Marking Guidance for Pre-Application White Paper and Invited Proposal and Disclosure of Proprietary Information other than to the Government.

IV.6.4.1. The pre-application white papers and invited proposals submitted in response to this BAA may contain technical and other data that the applicant does not want disclosed to the public or used by the Government for any purpose other than application evaluation. Public release of information in any pre-application white paper and invited proposal submitted will be subject to existing statutory and regulatory requirements.

IV.6.4.2. If proprietary information which constitutes a trade secret, proprietary commercial or financial information, confidential personal information, or data affecting the national security, is provided by an applicant in a pre-application white paper and/or invited proposal, it will be treated in confidence, to the extent permitted by law, provided that the following legend is included on the front page of the pre-application white paper and/or invited proposal:

> "For any purpose other than to evaluate the pre-application white paper and/or proposal, this data shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided that if an award is made to the applicant as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the agreement. This restriction does not limit the right of the Government to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s) _____ of this pre-application white paper and/or proposal."

Any other legend may be unacceptable to the Government and may constitute grounds for removing the pre-application white paper and/or invited proposal from further consideration without assuming any liability for inadvertent disclosure.

IV.6.4.3. The Government will limit dissemination of properly marked information to within official channels. In addition, the pages indicated as restricted must be marked with the following legend:

> "Use or disclosure of the pre-application white paper and/or proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the front page of this pre-application white paper and/or proposal."

IV.6.4.4. The Government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

IV.6.4.5. In the event that properly marked data contained in a pre-application white paper and/or invited proposal submitted in response to this BAA is requested pursuant to the Freedom of Information Act (FOIA), 5 U.S.C. § 552, the applicant will be advised of such request and prior to such release of information, will be requested to expeditiously submit to DTRA a detailed listing of all information in the pre-application white paper and/or invited proposal which the applicant believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the applicant will ensure that any information released by DTRA pursuant to the Act is properly identified.

IV.6.4.6. By submission of a pre-application white paper and/or invited proposal, the applicant understands that proprietary information may be disclosed outside the Government for the sole purpose of technical evaluation. DTRA will obtain a non-disclosure agreement from the evaluator that proprietary information in the pre-application white paper and/or invited proposal will only be used for evaluation purposes and will not be further disclosed or utilized.

IV.6.5. Pre-application white papers and invited proposal may be withdrawn by written notice received at any time before award. Withdrawals are effective upon receipt of notice by the Grants Officer via the e-mail address listed in Section VII.1.

## V. APPLICATION REVIEW INFORMATION

V.1. Evaluation Criteria. The evaluation criteria to be used for review of applications are listed below. Only the first two (2) criteria will be used to evaluate pre-application white papers; all four (4) will be used to evaluate invited proposals.

1. Technical/Scientific Merit. This area addresses the technical approach and the contribution of the research to advancing the scientific body of knowledge. It evaluates what research will be performed and how it will be accomplished. Three (3) factors will be considered. The factors are listed in the order of importance.

   - *Soundness of Approach.* This factor addresses whether the proposal clearly identifies and demonstrates an understanding of the scientific challenges and whether the project has a well-designed methodology, based on sound scientific principles, and how technical risks are addressed, mitigated, and managed.

- *Degree of Innovation.* This factor addresses the originality of the concept, its scientific merit, its creativity, and/or the novelty of the approach and the potential of the project to advance the scientific body of knowledge. The degree of innovation will be judged based on the innovation or originality that is appropriate to the proposed project.
- *Anticipated Scientific Impact.* This factor addresses the potential of the proposed work to provide greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts and the anticipated impact on the state of the science.

2. Responsiveness to Topic Area and Program. This area evaluates the extent to which the proposed research supports specific topic areas. It also considers the derivative benefit that may be realized by the performer and its organization through performance of the proposed research. The two (2) factors are weighted equal to each other.

   - *Responsiveness to Topic Area.* This factor addresses the responsiveness of the proposal to the objectives in the specific topic area and the contribution to the C-WMD science needs outlined in the topic.
   - *Derivative Benefit.* This factor considers training of students in science, engineering, and/or mathematics through the proposed research.

3. Program Capabilities. This area addresses key personnel, facilities, and major equipment required to accomplish the research. The two (2) factors are weighted equal to each other.

   - *Qualifications.* This factor will be scored based on the qualifications and availability of the proposed PI, co-PIs and other key personnel who are critical in achieving proposed objectives.
   - *Capabilities.* This factor considers the applicant's current or planned facilities and equipment that support achieving the proposed objectives. Capabilities evaluation will be based on the total capabilities of the assembled team that will be brought to bear as part of the proposed project.

4. Cost Realism and Reasonableness. This factor considers the adequacy and reasonableness of resources applied to each project task. This includes labor (in terms of time and mix), equipment, other direct costs, and indirect costs.

V.2. Review and Selection Process.

V.2.1. The pre-application white paper and proposal selection process will be conducted based upon a technical review as described in the DoDGARs [(32 CFR 22.315(c))] and includes the use of non-government peer-reviewers.

V.2.2. Each pre-application white paper and invited proposal will be reviewed within the period to which it was submitted.

V.2.3. Pre-application white paper (Phase I) evaluation will be based on two (2) equally weighted criteria described in Section V.1: (1) Technical/Scientific Merit and (2) Responsiveness to Topic Area and Program, which will each be scored as Green (acceptable), Yellow (acceptable with minor issues), or Red (unacceptable). The Government reserves the right to limit the number of Phase II invited proposals requested depending upon the volume of pre-application white papers submitted, the results of the Phase I evaluation, and the specific needs of the Agency.

V.2.4. Invited Proposal (Phase II) Evaluation will be based on the four (4) criteria described in Section V.1: Criteria (1) Technical/Scientific Merit and Criteria (2) Responsiveness to Topic Area and Program are equally weighted and are more important than Criteria (3) Program Capabilities which is more important than Criteria (4) Cost Realism and Reasonableness. All four (4) criteria receive a numerical score ranging from 1 (unacceptable) to 5 (outstanding).

V.2.5. Other factors that may be considered during the selection process are the possible duplication with other research currently funded by the Government, program balance across research topics, and budget limitations. Accordingly, proposals may be selected for funding which are not reviewed as highly as others, which are of higher risk and/or which may be of a higher cost. Preference will be given to university-led awards, single scope awards, and young investigator awards.

V.2.6. The Government reserves the right to select all, some, or none of the proposals, or any part of any proposal, received in response to this BAA and to make awards without discussions with applicants; however, the Government reserves the right to conduct discussions if determined necessary.

V.2.7. Additional details, including the due date for Phase II submissions, may be provided to applicants in the invitation email.

V.3. Technical and Administrative Support by Non-Government Personnel

V.3.1. It is the intent of DTRA to use non-government personnel to assist with the review and administration of submittals for this BAA.

V.3.2. All invited proposals will be reviewed by subject matter experts (peer reviewers) who are non-government personnel.

V.3.3. Participation in this BAA requires DTRA support contractors to have access to pre-application white paper and invited proposal information including information that may be considered proprietary. Existing DTRA contractors include but may not be limited to the following: TASC Inc (advisory and assistance services) and their subcontractors, Tauri, LLC and their subcontractors, Suntiva Executive Consulting and Brace Management Group (contract specialist support) and their subcontractors, BRTRC Inc., and ITT. Each contract contains organizational conflict of interest provisions and/or includes contractual requirements for non-disclosure of proprietary contractor information or data/software marked with restrictive legends.

V.3.4. All individuals having access to any proprietary data must sign a non-disclosure agreement that states the information in the pre-application white paper and/or invited proposal will only be used for evaluation purposes and will not be further disclosed or utilized.

V.3.5. All applicants to this BAA consent to the disclosure of their information under these conditions.

## VI. AWARD ADMINISTRATION INFORMATION

VI.1. Award Notices.

VI.1.1. A detailed review timeline is available to all applicants at www.dtrasubmission.net/portal. Applicants are responsible for checking the timeline at the www.dtrasubmission.net/portal for changes and updates to the schedule.

VI.1.2. Applicants of pre-application white papers that are not selected for invitation will be notified of the decision via e-mail to the BPOC listed in Block 5 of the SF-424 and the PI listed in Block 14 of the SF-424 provided at the time of submission.

VI.1.3. An invitation to submit a proposal will be extended to those applicants whose submissions were selected in Phase I. The invitation will be transmitted via e-mail to the BPOC listed in Block 5 of the SF-424 and the PI listed in Block 14 of the SF-424 provided at the time of submission.

VI.1.4. Applicants will be notified by DTRA of their selection/non-selection for award from the Phase II invited proposals via e-mail to the BPOC listed in Block 5 of the SF-424 and the PI listed in Block 14 of the SF-424 provided at the time of submission. Notification of proposal selection is not an authorization to begin work.

VI.1.4.1. A notice of selection should not be construed as an obligation on the part of the Government; only duly authorized procurement personnel may commit resources, this will be done by issuing a grant document to the selected applicant. Also, this notification must not be used as a basis for accruing costs to the Government prior to award. Selected applicants are not authorized to begin work, as any award is subject to successful negotiations (if determined necessary by DTRA) between the DTRA contracting division and the selected organization, and to the availability of funds.

VI.1.5. A debrief summary will be provided as part of all notification e-mails.

VI.1.6. All notifications will be made from notification@dtrasubmission.net. **E-mails to this e-mail address will not be answered or forwarded.**

VI.1.7. The applicants must be aware that it is their responsibility to ensure: (1) correct e-mail addresses are provided at the time of submission, (2) this e-mail notification reaches the intended recipient(s), and (3) the e-mail is not blocked by the use of ‘spam

blocker' software or other means that the recipient's Internet Service Provider may have implemented as a means to block the receipt of certain e-mail messages.

VI.1.8. If for any reason there is a delivery failure of these e-mail notices, **DTRA will not further attempt to contact the applicants**.

VI.2. Administrative and National Policy Requirements.

VI.2.1. The DTRA Grant Terms and Conditions may be found online at www.dtrasubmission.net/portal. (Note: There are different versions for different recipients. As the Terms and Conditions are updated, they will be posted on the www.dtrasubmission.net/portal.)

VI.2.2. All awards require certifications of compliance with national policy requirements. Statutes and government-wide regulations require some certifications to be submitted at the time of proposal submission. See Section IV.6.3 for the certification(s) required at the time of submission.

VI.2.3. CCR Registration. In accordance with 2 CFR 25.200(b), each entity applying to this BAA (that is not exempt under 2 CFR 25.110) is required to:

- Be registered in the CCR prior to submitting an application (or plan);
- Maintain an active CCR registration with current information at all times during which it has an active Federal award or an application (or plan) under consideration by an agency; and
- Provide its DUNS number in each application (or plan) it submits to the agency.

VI.2.4. Protection of Human Subjects.

VI.2.4.1. It is not anticipated that human subjects would be involved in basic research. If the proposed research does involve human subjects or materials, applicants are asked to justify the use of human subjects and to address the following issues: outline the human use, to include the source of the human subjects or materials involved in the research. Further information may be required if the proposal is successful.

VI.2.4.1.1 The Common Federal Policy for the Protection of Human Subjects, codified by the Department of Health and Human Services at 45 CFR 46 and implemented by the Department of Defense at 32 CFR 219.

VI.2.4.1.2 The recipient shall adhere to DTRA local clause 252.223-9002. The full text of this clause is as follows:

All research under this grant involving human subjects must be conducted in accordance with 32 CFR 219, 10 USC 980, and DoDD 3216.02, as well as other applicable federal and state regulations. Grantees must be cognizant of and abide

by the additional restrictions and limitations imposed on the DoD regarding research involving human subjects, specifically as regards vulnerable populations (32 CFR 219 modifications to subparts B-D of 45 CFR 46), recruitment of military research subjects (32 CFR 219), and surrogate consent (10 USC 980). DTRA Directive 3216.01 establishes the DTRA Human Subjects Protection Program, sets forth the policies, defines the applicable terms, and delineates the procedures necessary to ensure DTRA compliance with federal and DoD regulations and legislation governing human subject research. The regulations mandate that all DoD activities, components, and agencies protect the rights and welfare of human subjects of study in DoD-supported research, development, test and evaluation, and related activities hereafter referred to as "research". The requirement to comply with the regulations applies to new starts and to continuing research.

The DTRA directive requires that research using human subjects may not begin or continue until the Defense Threat Reduction Agency's Research Oversight Board (ROB) has reviewed and approved the proposed protocol. Grantees and subcontractors are required to submit a valid federal assurance for their organization (institution, laboratory, facility) that has been issued by either DoD or the Department of Health and Human Services, and documentation of review of proposed protocols by the local Institutional Review Board (IRB) to include consent forms for any planned research using human subjects to the DTRA ROB for its review through the Grants Officer's representative (if assigned) or the Grants Officer. The ROB review is separate from, and in addition to, local IRB review.

Written approval to begin research or subcontract for the use of human subjects under the proposed protocol will be provided in writing from the DTRA ROB, through the Grants Officer. A copy of this approval shall be maintained by both the Grantee and the government. Any proposed modifications or amendments to the approved protocol or consent forms must be submitted to the local IRB and the DTRA ROB for review and approval. Examples of modifications/amendments to the protocol include but are not limited to:

- a change of the PI
- changes in duration or intensity of exposure to some stimulus or agent
- changes in the information requested of volunteers, or changes to the use of specimens or data collected
- changes in perceived or measured risks or benefits to volunteers that require changes to the study

Research pursuant to such modifications or amendments shall not be initiated without IRB and ROB approval except when necessary to eliminate apparent and immediate hazards to the subject(s).

Research projects lasting more than one year require IRB review at least annually, or more frequently as required by the responsible IRB. ROB review and approval

is required annually. The Grantee or subcontractor must provide documentation of continued IRB review of protocols for ROB review and approval in accordance with these Terms and Conditions. Research must not continue without renewed ROB approval unless necessary to eliminate apparent and immediate hazards to the subject(s).

Non-compliance with any provision of this clause may result in withholding of payments under the grant pursuant to the grant's payments clause(s) and/or grant termination pursuant to the grant's termination clause(s). The government shall not be responsible for any costs incurred for research involving human subjects prior to protocol approval by the ROB.

VI.2.5. Animal Use.

VI.2.5.1. It is not anticipated that animal use would be involved in basic research. If the proposed research does involve animal use, however, applicants are asked to justify the use of animals and to address the following issues: any proposals that include animal studies or animal work must submit detailed information on the animal protocols to be used and verify the location where the studies will be conducted. Animal studies are subject to review and approval for safety and adherence to regulations. Further information may be required if the proposal is successful.

VI.2.5.2. The recipient shall adhere to DTRA local clause 252.235-9002 – Animal Use (Jul 2010). The full text of this clause is as follows:

If the proposed research involves the use of live nonhuman vertebrate animals, offerors are required to justify the use of animals by providing detailed information on the proposed animal use, to include the proposed species and number of animals planned, along with the location(s) where the animal study(ies) are planned. This information, if applicable, must be included in Volume III, Supplemental Information, of the Phase II full proposal. Additional information will be required if the proposal is selected for award subject to successful negotiations. The Animal Care and Use Review Office (ACURO), a component of the USAMRMC Office of Research Protections (ORP), must review and approve all animal use prior to the start of working with animals. Therefore principle investigators will be required to complete and submit the animal use appendix titled "Research Involving Animals", after award of the procurement instrument, which can be found on the ACURO website (https://mrmc-www.army.mil/index.cfm?pageid=Research_Protections.acuro&rn=1). Allow 2 to 4 months for regulatory review and approval processes for animal studies. Offerors are to build this review time into their project schedules.

DoD Directive 3216.1, dated April 17, 1995, provides policy and requirements for the use of animals in DoD-funded research along with Army Regulation 40-33. The DoD definition of animal is any live nonhuman vertebrate. All proposals that involve the use of animals must be in compliance with DoD Directive 3216.1 and AR 40-33.

DTRA requires that research using animals not begin or continue until the ACURO has reviewed and approved the proposed animal use. For animals, the provisions include rules on animal acquisition, transport, care, handling, and use in: (i) 9 CFR Parts 1-4, Department of Agriculture rules that implement the Laboratory Animal Welfare Action of 1966 (U.S.C. 2131-2156); and (ii) the "Guide for the Care and Use of Laboratory Animals," National Institutes of Health Publication No. 86-23.

VI.2.6. Biological Defense Research Program (BDRP) Requirements: BioSurety and Select Agent Use.

VI.2.6.1. Proposals must specify what Select Agent work will be conducted at the applicant's facility and what Select Agent work will be performed in other facilities. Proposals also must provide the source of the Select Agent(s), any appropriate registration information for the facilities, and specify the Laboratory Bio-safety Level. All Select Agent work is subject to verification of information and certifications. Further information may be required if the proposal is successful.

VI.2.6.2. For those institutions in which PI's are conducting research with Bio-safety Levels 3 and 4 material, a Facility Safety Plan must be prepared and made available during the project award phase in accordance with 32 CFR 626.18. For grants awarded to foreign institutions, you must follow either local or U.S. laws (as stated above) depending on which laws provide stronger protection. (DTRA requires that research using Select Agents not begin or continue until DTRA has reviewed and approved the proposed agent use. See URL: www.access.gpo.gov/nara/cfr/waisidx_99/32cfr626_99.html for a copy of 32 CFR 626.18, Biological Defense Safety Program.)

VI.2.7. Military Recruiting. This is to notify potential applicants that each grant awarded under this announcement to an institution of higher education, with exception of any grants awarded to institutions of higher education entirely located outside the United States and/or its territories, must include the following term and condition: "As a condition for receipt of funds available to DoD under this award, the recipient agrees that it is not an institution of higher education (as defined in 32 CFR 216) that has a policy of denying, and that it is not an institution of higher education that effectively prevents, the Secretary of Defense from obtaining the following for military recruiting purposes: (A) entry to campuses or access to students on campuses; or (B) access to directory information pertaining to students. If the recipient is determined, using procedures in 32 CFR 216 to be such an institution of higher education during the period of performance of this agreement, and therefore to be in breach of this clause, the Government will cease all payments of DoD funds under this agreement and all other DoD grants and cooperative agreements, and it may suspend or terminate such grants and agreements unilaterally for material failure to comply with the terms and conditions of award." 32 CFR 216 may be accessed electronically at http://ecfr.gpoaccess.gov/. If your institution has been identified under the procedures established by the Secretary of Defense to implement Section 558 of Public Law 103-337, then: (1) no funds available to DoD may be provided to your institution through any grant, including any existing grant; and (2) your institution is not eligible to receive a grant in response to this BAA. This is to notify

potential applicants that each grant awarded under this announcement to an institution of higher education, with exception of any grants awarded to institutions of higher education entirely located outside the United States and/or its territories, must include the following clause: 32 CFR 22.520 (DoDGARS 22.520), Military Recruiting and Reserve Officer Training Corps Program Access to Institutions of Higher Education.

VI.2.8. Export Control Notification. Applicants are responsible for ensuring compliance with any export control laws and regulations that may be applicable to the export of and foreign access to their proposed research. Applicants may consult with the Department of State with any questions regarding the International Traffic in Arms Regulation (ITAR) (22 CFR Parts 120-130) and/or the Department of Commerce regarding the Export Administration Regulations (15 CFR Parts 730-774).

VI.2.9. It is the policy of the DoD that the publication of products of basic research will remain unrestricted to the maximum extent possible. Pursuant to DoD policy, awardees are strongly encouraged to publish the results or findings of their research in peer-reviewed journals.

VI.2.10 Combating Trafficking in Persons. The recipient agrees to comply with the trafficking in persons requirement in Section 106(g) of the Trafficking Victims Protection Act of 2000 (TVPA), as amended (22 U.S.C. 7104(g)).

VI.2.11 Reporting Subawards and Executive Compensation. The recipient agrees to ensure they have the necessary processes and systems in place to comply with the reporting requirements of the Transparency Act, as defined at 2 CFR 170.320, unless they meet the exception under 2 CFR 170.110(b).

VI.3. Reporting. General requirements are provided below; however, each grantee should check the award agreement and its terms and conditions to determine the requirements for that specific award.

VI.3.1. Annual Progress Reports: Annual progress reports will be due no later than 1 September of each year. Grants effective after 31 May will not require a progress report until 1 September of the following year.

VI.3.2. Final Technical Reports: A comprehensive final technical report is required at the prior to the end of an effort, due on the date specified in the terms and conditions of the grant document.

VI.3.2.1. The purpose of the final report is to document the results of the effort.

VI.3.2.2. The final report will always be sent to the Defense Technical Information Center (DTIC) and reports may be available to the public through the National Technical Information Service (NTIS).

VI.3.3. The Federal Financial Report, SF425 is due annually, no later than 90 days after the end of the reporting period for all grants. The reporting period shall be from 1 July–30 June. First year reports shall have a reporting period of the start date of the grant through 30 June. Final reports shall be submitted no later than 90 days after the project or grant period end date.

VI.3.4. All reports shall be submitted to the Administrative Office identified in the Research Grant and as outlined in the Terms and Conditions of the award document.

VI.4. After-the-Award Requirements. Closeout, subsequent adjustments, continuing responsibilities, and collection of amounts due are subject to requirements found in 32 CFR 32.71 – 73 (Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations) and 32 CFR 32.61 – 63 (For-Profit Organizations).

## VII. AGENCY CONTACTS

VII.1. All administrative and programmatic correspondence should be directed to HDTRA1-BRCWMD-A@dtrasubmission.net.

Every effort will be made to provide a timely response to all inquiries; however, e-mails may not receive a response. Attachments will not be reviewed.

VII.2. Specific technical correspondence regarding the thrust areas as well as the topics may be directed to the following e-mail addresses:

Thrust Area 1: BRCWMD-TA1@dtrasubmission.net

Thrust Area 2: BRCWMD-TA2@dtrasubmission.net

Thrust Area 3: BRCWMD-TA3@dtrasubmission.net

Thrust Area 3 (CB): BRCWMD-TA3-CB@dtrasubmission.net

Thrust Area 4: BRCWMD-TA4@dtrasubmission.net

Thrust Area 5: BRCWMD-TA5@dtrasubmission.net

Please note that technical correspondence e-mails may or may not be reviewed and responded to; **attachments will not be reviewed**.

VII.2.1. Dialogue that assists the applicants in developing better pre-application white papers and invited proposals is encouraged.

VII.2.2. Questions regarding debriefing summaries for pre-application white papers that are invited to full proposals are encouraged.

VII.2.3. Requests to reconsider pre-application white papers and/or proposals, requests for additional information beyond the debriefing summaries for non-invites/non-

selections, and rebuttals to the debriefing summary (e.g., additional data, further explanation, etc.) WILL NOT be considered under any circumstances.

## VIII. OTHER INFORMATION – TOPICS

VIII.1. Topics for future periods with corresponding pre-application white paper due dates will be published via amendments to this BAA. Topics from previous period may or may not be repeated. DTRA will not provide additional information regarding the posting of future topics, including dates for posting, the potential for a topic to be repeated in out years, the potential for similar topics to be posted, and/or topic details in advance of issuance of an amended BAA.

VIII.2. This BAA, in addition to any amendments issued in conjunction with this BAA, will be posted to the Grants.gov Grant Opportunities Website (www.Grants.gov) and for informational purposes to the DTRA Basic and Fundamental Research Portal (www.dtrasubmission.net/portal).

Note: The DTRA Basic and Fundamental Research Portal (www.dtrasubmission.net/portal) is available to all applicants. Information available at the portal includes, but is not limited to, the following: a detailed timeline for this BAA, templates that may be used when preparing pre-application white papers and invited proposals, sign-in for applicants to view the status of their submission(s), and a list of previous awards made by the Basic Research for C-WMD Program.

**DTRA Basic Research Needs**

***PerA-Topic 1: Sensing Fissile Material at Long Range using Novel Methods (Thrust Area 1)***

Average Award Amounts for PerA-Topic 1:

- Single Scope Awards will average $150,000 per year.
- Multidisciplinary Awards will average $350,000 per year.

**Background:** This topic seeks to advance the knowledge of novel sensing methods providing a foundation for the ability to non-invasively detect shielded fissile material, with low signal-to-noise ratios, at long range using other methods than the direct sensing of the gamma rays and neutrons from the radioactive decay of fissile material.

Conventional methods of sensing fissile material by direct detection of gamma rays and neutrons have limited distances of effectiveness. Current standoff detection distances are on the order of meters[5]. Research already funded hopes to increase this distance to somewhere between 10 to 100 meters[6]. Increasing the standoff detection distance to 100 meters or more is desirable. Increasing the standoff detection distance to 1,000 meters would be revolutionary.

[5] Norman, D.R., et al., *IEEE Nuclear Science Symposium Record*, vol. 2, pp. 1004-1008, Oct. 2005.

[6] Ziock, K.P, et al., *IEEE Transactions on Nuclear Science*, vol. 51, pp. 2238-2244, Oct. 2004.

One area of exploration that is of interest is the creation and properties of secondary effects caused by radiological materials interacting with the surrounding environment and shielding materials. An area of exploration that is not of interest is the use of cosmic-ray muons to detect high-Z material[7]. Research advancing the knowledge of novel methods to detect fissile material may lead to the ability to remotely sense shielded fissile material, with low signal to noise ratios, at long range.

**Impact:** This topic is important to the counter-WMD mission of DTRA by addressing the need to extend detection of fissile materials and nuclear weapons to distances beyond the short-range that is the current state-of-the-art. Developing novel detection methods could lead to the ability to sense shielded fissile material, with low signal to noise ratios, from standoff ranges of hundreds of meters to as great as 1,000 plus meters.

**Objective**: This topic explores novel methods and advancements in the ability to remote sense shielded fissile material, with low signal to noise ratios, from significant standoff ranges. Specific interest includes methods not utilizing direct sensing of gamma rays and neutrons from the decay of fissile material.

Research areas may include, but are not limited to, the following:

- Examine the interactions of non-ionizing radiation with fissile material and explore novel concepts for possible signature generation.
- Advance the knowledge of physical or chemical interactions of radiological materials with adjacent explosive/energetic materials, and explore novel concepts for possible signature generation.
- Examine interactions of nuclear radiation (such as gamma photons and neutrons) with adjacent electronic materials, and identify and investigate resulting novel signatures that may be induced in these materials and associated structures.
- Examination of the use of ultrasound to sense fissile material through intervening media.

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### ***PerA-Topic 2: Integration of Hyperspectral information to enhance Radiation Detection Modeling (Thrust Area 1)***

Average Award Amounts for PerA-Topic 2:

- Single Scope Awards will average $150,000 per year.
- Multidisciplinary Awards will average $350,000 per year.

**Background:** Radiological detection transport codes play an important role in DTRA's efforts to develop enhanced detection capabilities, and to predict the performance of these capabilities as part of operational activities. Modeling these capabilities accurately in specific settings requires a good understanding of backgrounds and materials that may interact with source fluxes. In some cases, background information is available, however generally such information is quite abstract. As a result, transport code representations of these environments rely upon overly simplistic generalized descriptions of backgrounds, attenuation and moderating materials, and

[7] (Benettoni, M., et al., *IEEE Nuclear Science Symposium Conference Record*, vol. 2, pp. 1021-1025, Jan. 2008)

similar environmental conditions.

**Impact:** The ability to reduce uncertainties in environmental, background, and attenuation/moderating assumptions in the absence of, or to supplement, available data, would enhance capabilities to detect radiological sources. This would allow greater certainty in deploying these capabilities and greater accuracy in the modeling of these capabilities for a wide variety of virtual and real environments.

**Objective:** The objective of this solicitation is to support the understanding of how hyperspectral sensor information may be used to inform, and assist in the more rapid generation of transport modeling code scenarios. Such capabilities would also have utility for allowing more accurate selection and placement of detectors for specific environments and would enhance the development of more capable detection algorithms and detectors.

Research areas may include, but are not limited to, the following:

- Methods to more quickly and accurately identify correlations or other functional relationships between features in multi-spectral imagery and responses observed in 3 dimensional radiation codes.
- Methods to employ deterministic, or 1 dimensional transport approximations, in support of reducing 3 dimensional code characterizations of complex geometries and areas, particularly in cases where either detectors, or sources, may move.
- Methods to predict neutron or gamma background maps using analytic models based on terrain, and cosmic or environmental features.
- Other methods to more accurately characterize radiological detection engagements using exogenous information.

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***PerA-Topic 3: Ultra-low Level Detection of Nuclear Materials (Thrust Areas 1 and 5)***

Average Award Amounts for PerA-Topic 3:

- Single Scope Awards will average $150,000 per year.
- Multidisciplinary Awards will average $350,000 per year.

**Background:** Low level detection of radioactive materials has become increasingly important to provide a variety of markers across a range of forensics programs. The ability to detect ultra-trace levels of non-ubiquitous occurring isotopes can be used to locate and identify activities involving the transport and handling of radioactive materials, testing of subcritical assemblies, or small scale batch processing of nuclear materials. Research is needed to achieve these ultra-low levels of detections through either radiometric (gamma-ray, neutron activation, beta, alpha or coincidence techniques) or atom counting techniques (mass spectroscopy, laser-induced breakdown spectroscopy, etc.). Levels needed are from a few to a few thousand atoms. Isotopes of interest are transuranics, fission products, and other isotopes that will be activated in the presence of a neutron source. Purification methods that can further enhance the signal to noise ratio are also important.

**Impact:** Special nuclear materials, materials that have been activated by neutrons, and short and medium lived fission products are key indicators of potential nuclear weapons proliferation,

development, and smuggling/transport. The ability to achieve ultra-level detection of these materials can provide valuable forensics evidence and can lead to a capability to detect facilities, transportation routes, and holding areas for these WMD.

**Objective:** Low level detection of radioactive materials has become increasingly important to provide a variety of markers across a range of forensics programs. The ability to detect ultra-trace levels (a few to a few thousand atoms) of non-ubiquitous occurring isotopes can be used to locate and identify activities involving the transport and handling of radioactive materials, testing of subcritical assemblies, or small scale batch processing of nuclear materials. This research will lead to the development of improved detection technologies of low-level amounts of radioactive materials aiding the counter proliferation/counter-trafficking of WMD and potential WMD components.

Research areas may include, but are not limited to, the following:

- Radiometric methods that use gamma-ray, neutron activation, beta, alpha, or multi-coincidence techniques that can enable ultra-low level detection of a range of isotopes (e.g. transuranics, fission products, and other isotopes that will be generated in the presence of a neutron source).
- Unique methods and techniques that are non-radiometric, such as atom counting techniques that can enable ultra-low level detection of a range of isotopes (e.g. transuranics, fission products, and other isotopes that will be generated in the presence of a neutron source).

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***PerA-Topic 4: Science of Advanced Silicon Compatible Technologies (Thrust Area 3)***

Average Award Amounts for PerA-Topic 4:

- Single Scope Awards will average $150,000 per year.
- Multidisciplinary Awards will average $350,000 per year.

**Background:** "Moore's Law" has observed that the number of transistors that can be reasonably placed on a single integrated circuit has doubled approximately every two years. This trend has continued for more than half a century, but there has been concern that this trend will run out of steam with current complementary metal–oxide–semiconductor (CMOS) technology within a few years. These limits relate to practical physical sizes of integrated circuits (ICs), the ability to discriminate between "1's" and "0's" as supply and control voltages are necessarily decreased, and problems related to ever smaller numbers of electrons in charge transfer packet. One approach to dealing with the need to develop new technology for increasing electronic IC device capability and performance has been to investigate completely new systems, such as compound semiconductors, heterostructure field effect concepts, and rad-hard non-silicon high mobility transistor circuits. These innovations come at a price, however, and mandate a complete makeover of design, fabrication, and utilization infrastructure.

This topic involves the exploration of possible high performance and capability technologies that are either silicon based or compatible with silicon CMOS, at least to the extent that hybrid CMOS on-chip circuits can provide input and output. DTRA is also particularly interested in the radiation and EMP effects related to these new prospective technologies with a view of drastically reducing shielding requirements, enhancing robustness and recovery, and mitigating and compensating for short- and long-term radiation effects. Some of the basic science elements

of these technologies include photonic coupling, signal processing and interconnect related to "silicon photonics," "plasmonic" signal processing with CMOS-compatible input/output, "memristor" concepts and related signal processing circuit design elements which are intrinsically rad-hard, and the science of new "spintronic" device concepts and prototypes which may be integrated with and utilize the capabilities of CMOS.

**Impact:** The systematic advance of "Moore's Law" coupled with the introduction of new and disruptive technologies to meet this challenge may provide vulnerabilities of concern to DTRA, e.g. radiation effects associated with electronic control, measurements, stability, and reliability. Since it is very likely that new technologies based on the utilization of relatively new physical concepts, while still compatible with CMOS, will dominate these new photonic and electronic infrastructures, it is crucially important for the DoD to understand which hybrid technologies hold the greatest promise for the needs of the warfighter of the future.

**Objectives:** The objective of this topic is to define and understand the behavior and possible limits of new CMOS compatible technologies. The emphasis is on the basic research related to physics and radiation effects of the intersection of appropriate materials with the high performance functionality of advanced photonic and electronic concepts. Research of interest will consider the radiation effects coupled with possible new silicon materials technologies.

Research areas may include, but are not limited to, the following:

- Experimental demonstrations, theoretical models, and possible computer simulations of new advanced physics and possibly rad-hard concepts for hybrid CMOS that extend the ideas of circuit and device performance.
- Experimental materials studies related to the underlying science of very high performance heterostructure structure technologies, such as GaN/InGaN quantum wells, on silicon substrates incorporating CMOS input/output/control.
- Studies of the utilization of silicon as a propagation media for spintronic signal propagation and interconnect.
- Experimental studies of the efficacy of graphene technology coupled with silicon substrates and related CMOS, and the implication of radiation on these structures.
- Experimental studies of silicon photonic infrared interconnect and possible radiation effects.
- Studies of the materials and radiation effects implications of the integration of metamaterials with silicon electronic technology.
- Studies of the integration of silicon and the use of silicon for plasmonic signal propagation and processing coupled with the implications of a broad spectrum of radiation effects.
- Studies of the radiation effects implications of silicon materials for memristors, a two terminal technology wherein the resistance is controlled by an external electromagnetic field.

***PerA-Topic 5: Science of Metamaterials for Radiation-Hardened Electronics, Acoustic and Photonic Functions (Thrust Area 3)***

Average Award Amounts for PerA-Topic 5:

- Single Scope Awards will average $150,000 per year.
- Multidisciplinary Awards will average $350,000 per year.

**Background:** Recently there has been a surge in research related to metamaterials that offer special properties for electromagnetic (EM) propagation, localization and control of "light" over a very broad spectrum from x-rays down to microwave frequencies. These "photonic crystals" if extended to three dimensions may support new concepts in optical computing, which could be intrinsically radiation hard. Specifically fabricated metamaterials may also demonstrate mechanisms for "cloaking" or invisibility by virtue of their unusual property of negative refraction index. These metamaterials neither absorb nor reflect light but redirect the lightpath.

Unlike natural materials which are constructed at a chemical level, artificial composites of metamaterials comprise ordered structures employing two or more materials. Although some forms of metamaterials have been known to exist since the 1940s, only recently have the full extent of their novel attributes been appreciated. "Invisibility" using metamaterials has a property of casting no shadows. Absence of the magnetic field has also been reported. These materials are also known as left-handed materials since the Poynting vector points in the "wrong" direction.

Limits on how far apart atoms are positioned in a metamaterial impose limits on what wavelengths of the electromagnetic spectrum can be obscured. Known metamaterials work best in the microwave or infrared regime of the electromagnetic spectrum. However, the possibility of invisibility to a larger portion of the electromagnetic spectrum, including the visible band, has been described by some researchers. These advancements are facilitated by novel geometrical arrangements of certain materials rather than new compositions. If arrangements featuring smaller than the visible wavespan of electromagnetic radiation can be generalized, it may be possible to extend invisibility to the ultraviolet (UV), x-rays and gamma rays. Furthermore, important applications would become possible if the principles of "Transformational Optics" could also be applied to acoustics or blast waves. In addition, metamaterials may find utilization as propagation media for plasmons, opening new possibilities for signal processing. Metamaterials for acoustic and seismic signal processing are also possible areas of exploration.

In contrast to bending or diverting the electromagnetic waves, researchers have shown that negative refraction index metamaterials and metamaterial-emulators can be used to make "superlenses" which can be used for high resolution imaging. These lenses have already been demonstrated in the microwave, near infrared (IR) and optical regimes. However, the fabrication imperfections at nano-technology levels have limited high resolution imaging. Some of the limitations of the "superlenses" have been overcome by the recently invented hyperlenses. These lenses could possibly be made in very small sizes for the purpose of focusing or concentrating the energy instead of imaging. In addition, lenses for high-gain antennas, beam steerers, band-pass filters, and special sensors might also be possible, all of which may be

intrinsically radiation hard.

**Impact:** Since metamaterials are not bulky, the warfighter may have a new capability to protect personnel and equipment against UV, x-rays, γ-radiation, and electromagnetic pulse (EMP) provided the invisibility can be achieved for the short wavelength end of the electromagnetic spectrum. The bulky shielding to protect man and material against x-rays, radioactivity, or EMP could, perhaps, be shed and may lighten the warfighter's burden. Bending of acoustic energy would open up new ways of focusing blast waves on targets minimizing the collateral damage to the unintended nearby objects. Protection against IR may also provide insulation against heat.

**Objectives:** The objective of this topic is to define and understand the behavior and possible limits of new metamaterials. The emphasis is on the basic research related to physics and chemistry of metamaterials that may be of relevance to the warfighter, not the applications.

Research into theoretical models, computer models and experimental demonstrations may include, but are not limited to, the following areas:

- Metamaterials that extend the ideas of invisibility or transformational optics to wavelengths beyond IR and visible.
- Metamaterials that bend acoustic waves, blast waves and matter waves.
- Metamaterials that cloak large objects over the entire electromagnetic spectrum and ways to defeat the invisibility cloaks.
- Ways to focus energy (x-rays, light, heat, microwave or blast) at all incident angles using "receptors".

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### ***PerA-Topic 6: Interrogation of Mechanisms for Cellular Resistance to Radiation Damage using Deinococcus radiodurans as a Model System (Thrust Area 3)***

Average Award Amounts for PerA-Topic 6:

- Single Scope Awards will average $150,000 per year.
- Multidisciplinary Awards will average $350,000 per year.

**Background**: Cell death following exposure to ionizing radiation (IR) is commonly attributed to profound DNA damage that is sufficient to overwhelm cellular repair mechanisms. However, recent research indicates that protein, rather than DNA, damage may be a more likely contributor to the deleterious biological effects associated with acute radiation exposure. Although DNA damage is the ultimate cause of mortality, the rate and efficiency at which DNA integrity is restored by repair proteins is a proximate factor in dictating cell fate.

Polyextremophilic bacteria can serve as model systems for understanding mechanisms by which protein stability influences cell survival. *Deinococcus radiodurans* is a robust bacterium that can survive acute IR doses 100 times greater than the lethal dose for most other bacterial species and 2000 times greater than the lethal dose for humans. Surprisingly, however, *D. radiodurans* appears to possess essentially the same suite of repair proteins as its radiosensitive microbial counterparts. The finding has led to researchers to hypothesize that the remarkable resistance of *D. radiodurans* to IR is more likely related to protection of vital repair enzymes from oxidative damage than to a unique or hyperactive repair system.

Daly *et al.*[8] demonstrated that the cytosolic concentration of manganese ions ($Mn^{2+}$) in *D. radiodurans* was nearly 300 times that of bacteria exhibiting less resistance to IR. In addition, the manganese-to-iron ratio was substantially higher. The researchers speculated that high intracellular $Mn^{2+}$ exerts a protective influence by shielding exposed metallo-organic clusters from the detrimental effects of toxic reactive oxygen species (ROS) generated during irradiation. However, the underlying mechanism(s) contributing to enhanced resistance to IR have not been elucidated, and the specific components of the "detoxifying" system, cofactors and targets of $Mn^{2+}$ complexes, and precise mechanisms of ROS neutralization remain to be explored.

**Impact**: The proposed research is responsive to the National Military Strategy to Combat Weapons of Mass Destruction[9] (2006) with regard to its dictum for minimizing WMD effects in order to sustain military operations in a "WMD environment" and to provide support for domestic authorities in the event of a WMD incident. Developing a greater understanding of the mechanisms contributing to cellular protection against IR exposure will provide insight for future research efforts designed to develop novel prophylaxes, diagnostics, and detection technologies. Further, follow-on research efforts can employ the parameters identified as a result of conducting the work described herein to synthesize unique metallo-organic compounds that would meet or exceed the performance of naturally-produced compounds.

**Objective**: The proposed research seeks to characterize $Mn^{+2}$ complexes associated with protection of the cytosolic proteins against ROS and to develop a mechanistic understanding of the observed protective effect. Research conducted under the auspice of this topic should elucidate the structural relationships of the manganese complexes and metallo-proteins (e.g., ferro-proteins) by evaluating the following: Gibbs free energy, true oxidation state, and kinetics parameters to include ligand lability and ligand exchange reactions.

Research areas may include, but are not limited to, the following:

- Identify $Mn^{2+}$ complexes putatively related to protection of proteins from IR damage.
- Purify and characterize the identified complexes structurally, functionally and chemically.
- Explore functional roles for $Mn^{2+}$ in maintaining protein stability, especially that of Fe-S cluster-containing enzymes.
- Elucidate the structural parameters necessary to maintain cytosolic protein stability in the presence of ROS species produced as a result of IR exposure.
- Identify ROS species present in the cytosol subsequent to IR exposure.
- Relate $Mn^{2+}$ concentration to the formation and longevity of ROS species.
- Determine whether IR-resistant mechanisms in bacteria may be extrapolated to mammalian cell lines.

[8] (*Science* 306:1025-1028)

[9] National Military Strategy to Combat Weapons of Mass Destruction. 2006. Chairman of the Joint Chiefs of Staff. Washington, DC, 20318.

***PerA-Topic 7: Identification and Characterization of Conserved Elements in Zoonotic Viruses (Thrust Area 3)***

Average Award Amounts for PerA-Topic 7:

- Single Scope Awards will average $150,000 per year.
- Multidisciplinary Awards will average $350,000 per year.

**Background:** Approximately 75% of emerging pathogens are known zoonotic agents. Because human infection caused by such agents is often associated with acute morbidity, zoonotic pathogens are regarded as significant threats to public health. Viral transmission can occur as a result of direct contact with infected animals or via intermediate vector species. However, several viruses causally linked to human epidemics transitioned from a non-human to human host at some point in their respective evolutionary histories thus enabling human to human disease transmission. Researchers hypothesize that many of the infectious diseases linked to high rates of mortality in humans emerged as a result of "species jumping" from animals to humans during the last 10,000 years. A recent example is the emergence of swine-origin H1N1 influenza A virus (A/H1N1pdm) that putatively resulted from cross-species transmission of the virus from pigs to humans.

Previous research has demonstrated that certain conditions must be satisfied in order for a virus to become established in a novel host species. The virus must be able to successfully breach the new host's cell receptor barrier and must subsequently adapt to a potentially unique suite of cellular responses in order to propagate through a population. Currently, the underlying molecular factors that allow viruses to traverse taxonomic lines are not well-characterized. Numerous studies have evaluated response and adaptation in host species, but limited research efforts have been dedicated to understanding the viral elements that contribute to species jumping events. Identification of common elements that have been conserved across viral lineages with documented propensity for switching host species will enable prediction of taxonomic conversion and may ultimately contribute to the development of preventive measures. The present topic aims to effectuate foundational research pertaining to conserved genotypic and phenotypic elements in zoonotic viruses that can be subsequently related to transmissibility across diverse taxonomical lines.

**Impact:** Foundational knowledge regarding the structure and function of evolutionarily-conserved viral elements will enhance predictive capabilities so that outbreak scenarios can be anticipated and effectively subverted. In addition, such research will prove useful to those charged with anticipating the genetically engineered viruses of the future, whether they are natural or anthropogenic in origin.

**Objectives:** The primary objective of the research described herein is to identify and characterize viral factors that contribute to species jumping. Of particular interest are single-stranded negative strand RNA viruses.

Any computational modeling performed should be supported at least partly by new data generated by the investigator as a result of conducting work associated with this research topic. Investigation of "spillover" events is not the primary focus of the topic. Investigation of viruses outside the Orthomyxoviridae family is strongly encouraged.

Research areas may include, but are not limited to, the following:

- Identification of common genotypic and/or phenotypic elements in pseudotyped zoonotic viruses adapted *in vitro* to a new host species.
- Structural and function characterization of identified elements.
- Whole genome sequence analysis of viruses with documented ability to traverse taxonomic lines pursuant to validation and testing of a novel computational model describing species jumps.
- Examination of evolutionary trends/patterns in viruses with data generated from the aforementioned sequence analysis.

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***PerA-Topic 8: Meso-scale Diagnostics for Dynamic Events in Opaque Particulate Composites (Thrust Area 4)***

Average Award Amounts for PerA-Topic 8:

- Single Scope Awards will average $150,000 per year.
- Multidisciplinary Awards will average $350,000 per year.

**Background:** It is desired to neutralize WMD using air-dropped ordnance that must penetrate or otherwise gain entry into WMD locations, activate a dispersal mechanism (typically driven by high explosives), couple with WMD items, and neutralize these items. Current inventory munitions impact targets at rates of ~300 m/s. Fragments driven by high explosives have initial velocities of 1,000-2,000 m/s. Shaped charges travel on the order of multiple km/s. As a result, counter-WMD events occur at high rates ($10^2$-$10^7$ $s^{-1}$) where physical and chemical changes can take place at nanosecond times scales, and necessarily involve a wide variety of highly-heterogeneous particulate materials such as: earth materials (e.g. sand, sandy clay, limestone, granite, mixed strata of such, etc.), energetic materials (e.g., high explosives, metal particles, reactive materials, etc.) and WMD component materials (e.g., chemical, biological, radiological, etc.).

WMD-defeating systems are designed by using engineering hydrocodes that simulate the behavior of proposed weapon designs and troubleshoot solutions prior to the performance of expensive mid/full-scale tests. The hydrocodes can produce excellent results if high-fidelity material models are available. We are currently pursuing meso-scale modeling of composite particulate materials, to push material models from the micro-scale of chemical bonds and single-component crystals to multi-component composite particle systems. These meso-scale models require validation via measured particle/ensemble behaviors and interactions at the meso-scale. For the purpose of this topic, the meso-scale is defined as the scale of the individual particles in the system. For example, the scale for a typical explosive would be ~microns, while for sand it would be ~millimeters.

Conventional fast dynamic or high rate experimental measurements employ length scales that are $10^1$-$10^3$ larger than the pertinent meso-scale interactions. With the advent of nano-material concepts, flexible electronics of micron length scales and faster spectroscopic techniques, new meso-scale diagnostic for high rate ($10^2$-$10^7$ $s^{-1}$) events where pressure, temperature and chemistry may be dynamically changing every nanosecond, in multi-component multi-scale

particulate composites that are opaque, may not be an insurmountable challenge. For testing purposes, opaque particulate composites may be prepared with embedded nano particles that record or register in-situ shock pressures independent of temperature or vice versa. Flexible opto-electronics may be placed at grain boundaries to measure grain-to-grain impulse transfer during high velocity impact. When the material is prepared with "interrogators" embedded, it is important to ensure that the interrogators will not change the meso-scale properties or the dynamic response of the system. Further, the post-event retrieval and analysis required to forensically measure event characteristics must be convenient and efficient. Combinations of such methods can be employed to measure in-situ time-resolved chemical reactions occurring at nano-second time scales in energetic materials.

**Impact**: This research will enable the validation of meso-scale material models for pervasive particulate composites and enable the use of hydrocodes to accurately predict responses of counter-WMD systems. Accurate weapon simulations will allow intelligent design of new systems without needing multiple system tests at multiple scales, making the development of new systems much cheaper and more efficient.

**Objectives:** This research topic seeks meso-scale (from 1 μm up to several mm) diagnostics for high rate ($10^2$-$10^7$ $s^{-1}$) events where pressure, temperature and chemistry may be dynamically changing on the nanosecond scale, in multi-component multi-scale particulate opaque composites. Specific emphasis should be given to the measurement of data which will validate meso-scale computational techniques. White papers should address the critically important aspect of ensuring that any embedded gauges or measuring devices do not disturb or change the meso-scale interactions.

Research areas may include, but are not limited to, the following:

- In-situ methods to measure shock pressures and temperatures (independent of each other) from several atmospheres (atm) up to 50 GPa or hundreds of degrees to several thousand K, in solid composite opaque material composed of particles of various sizes, shapes and sometimes filled with soft polymeric binder or liquid (moisture) between particles.
- In-situ recording of impulse and pressure transfer across grain boundaries during shock propagation, especially when local stresses in particulate media can deviate from the average by an order of magnitude or more.
- In-situ determination of temperature heterogeneities on the surface (boundaries) and inside deforming particles in composites. In particular, direct observation of localized energy dissipation or ‘hot spots’ in shock-initiated energetic composites that include explosive crystals, binder and metal particles.
- In-situ measurements of chemistry, techniques to directly measure the chemical initiation and kinetics (chemical concentrations, internal energy distributions, etc.) at high repetition rates (> kilohertz) with nano to micro second time resolution to capture critical initial and long-term chemical conditions.
- In-situ evaluation of strength of individual grains when loaded by diametrically-opposed forces (e.g., dynamic Brazilian), the hardness and fracture toughness of individual grains loaded statically, at very high rates.

***PerA-Topic 9: New Materials with Fast Energy Release using Novel Methods (Thrust Area 4)***

Average Award Amounts for PerA-Topic 9:

- Single Scope Awards will average $150,000 per year.
- Multidisciplinary Awards will average $350,000 per year.

**Background:** The DoD, motivated by assessments of future military requirements for significantly smaller, lighter, more versatile weapon systems, needs new capabilities that would provide a reduction of warhead size and controllable or tunable energy release. It is recognized that, while a number of existing technical approaches can be systematically combined in order to make marginal improvements in warheads, significantly new capabilities in stored energy density and energy release rates are required for orders-of-magnitude improvements.

Regarding energy density of energetic materials, as seen by efforts over the past 50+ years, chemical synthesis approaches that seek new energetic molecules by approaches that investigate new variations within traditional C, H, O, N families will likely yield only modest, incremental increases in energy density. Non-traditional approaches using novel types of energetic materials and processes hold more promise to achieve much higher energy densities. For instance, hydrostatic or shear pressure synthesis using anvil cell technologies have been employed to prepare metastable extended structures that are stable at ambient conditions. Polymerization of inorganic nanoparticles has been achieved. Two-dimensional ultrathin single-crystal sheets on the micrometer scale have also been achieved. These achievements indicate that three-dimensional nanoparticle frameworks or self-assembly of nanoparticles into larger single-crystalline objects are future possibilities. The creation of new nanoscale intermetallic materials that combine the exothermic nature of intermetallic reactions with simultaneous hot gas evolution not involving organic constituents may yield new capability to achieve enhanced energy density and explosively fast energy release.

Regarding controlling or tuning energy release, a clearer understanding of sensitivity to initiation is a critical factor. This includes a need for a clearer picture of the nature or mechanisms of initiation, particularly at the molecular and crystalline scales. Novel or non-traditional materials or states of condensed matter or compositions, which provide controllable, tunable and reproducible production of energy release, are desired. For instance, the isotopic kinetic effect on explosives may be one approach to improve explosive survivability and understand intrinsic sensitivity at the molecular level. Crystal morphology can affect sensitivity, with sharp, needle-like shapes generally producing more sensitive formulations compared to those using more uniform, prismatic shapes with rounded edges.

**Impact:** This research will significantly enhance the DoD's ability to decisively defeat an adversary's WMD and hardened or deeply-buried targets with smaller, lighter, more versatile weapon systems; research could greatly enhance the ability to deal with targets sheltered in urban terrain with significantly reduced risk of collateral damage.

**Objectives:** This research topic seeks new energetic materials with fast energy release using novel methods.

Research areas may include, but are not limited to, the following:

- Predictive calculations that show the possible existence of novel high energy materials that are stable and insensitive at ambient conditions.
- Hydrostatic or shear pressure synthesis using anvil cell technologies to prepare meta-stable extended structures that are stable at ambient conditions.
- Synthesis of three-dimensional nanoparticle or nano-rod frameworks designed for high energy storage with fast energy release.
- Nanoscale intermetallic materials that combine the exothermic nature of inter-metallic reactions with simultaneous hot gas evolution not involving organic constituents.
- Radically different methods utilizing the electronic nature of initiation, or the isotopic kinetic effect or crystal morphology to demonstrate control over initiation and energy release.
- Other innovative, non-traditional approaches for achieving high energy density materials, greater control over energy release, and fundamental understanding of these energy storage and release processes.

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***PerA-Topic 10: Radio-noble Gases and Chemical Fractionation (Thrust Area 5)***

Average Award Amounts for PerA-Topic 10:

- Single Scope Awards will average $150,000 per year.
- Multidisciplinary Awards will average $350,000 per year.

**Background:** Onsite inspection of potential underground nuclear explosions is part of the Treaty language within the Comprehensive Nuclear Test-Ban Treaty (CTBT). A significant challenge to conducting a successful onsite inspection (OSI) is understanding the source activation products likely to be encountered by an inspection team. Rapid and efficient chemical fractionation of ground samples collected during an onsite inspection represents a significant challenge in the post detonation environment which is dependent on the environment of the explosion (e.g., sand, hard rock, or gravel). For example, well contained underground explosions have released radioxenon isotopes, but few, if any, of the other unique signatures or activation products that may be expected. The development of robust chemical fractionation models along with transport in the underground environment will advance the knowledge base that is currently not well defined and poorly understood for onsite inspections to detect clandestine underground nuclear explosions.

**Impact:** The research of chemical fractionation and transport in complex environments addresses DTRA's counter-WMD need by providing the scientific rigor needed to develop equipment and concept of operations to conduct a successful OSI for current treaties and for any future treaties.

**Objectives:** Research of theoretical principles for use in predictive models for the transport and fate of unique identifiers and neutron activation products from underground nuclear explosions, i.e., high temperature dense plasmas within a nuclear explosion, is the focus of this topic. The potential range of analytes includes mixtures of particulates, gases and liquids. Of particular interest is the radioxenon isotopes, their parent and daughter products (iodine and cesium), and Ar-37.

Research areas may include, but are not limited to, the following:

- Theoretical underpinnings that predict the likely chemical fractionation and speciation of the dominate treaty-defined products and neutron activation products starting from the plasma immediately after detonation to ambient temperatures in the underground environment.
- Determination of the migration and transport of radioxenon isotopes (Xe-131m, Xe-133m, Xe-133, Xe-135, Xe-137, etc.) and their parent and daughter products. This research should seek to identify differences within different underground environments from immediately after the explosion up to 24 months later.
- Determination of the production of Ar-37 in different geologic environments along with its migration within these underground environments from immediately after the explosion up to 24 months later.
- More generally, determination of other promising activation products and their parent and daughter products is desired in different geologic environments along with its migration within these underground environments from immediately after the explosion up to 24 months later.

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***PerA-Topic 11: Flora, Fauna, and Microorganisms as Screening Indicators for Nuclear Tests (Thrust Area 5)***

Average Award Amounts for PerA-Topic 11:

- Single Scope Awards will average $150,000 per year.
- Multidisciplinary Awards will average $350,000 per year.

**Background:** Significant challenges to conducting a successful onsite inspection of a suspected nuclear explosion are the large area to be covered and the potential delay between the event of interest and access to the site. Given these operational demands, rapid and sensitive methods are needed to locate and prioritize suspected sites and then to effectively gather and analyze samples for radiometric signatures indicative of a recent nuclear test. It is important to identify methods that are specific to the unique environmental challenges of a nuclear explosion. Uptake of radiochemical products, with half-lives' of a few days to several years, by native flora, fauna, and microorganisms might provide a clear indication of recent testing. These are likely to be found across a wide range of environmental conditions and will be strong bio accumulators for a range of radioactive isotopes are of particular interest.

**Impact:** The ability to use flora, fauna, and microorganisms as indicators of radiation contamination and in particular nuclear explosions is directly related to DTRA's mission of reducing and preventing the use of WMD. Rigorous science is needed to achieve a successful onsite inspection and this topic ensures that critical and viable methods are explored to assist in this effort.

**Objectives:** Identification of likely flora, fauna, and microorganism pathways to include airborne, waterborne, or soil entrainment that are found across a broad range of terrestrial and subterranean environments is of interest. It is important to note that only native flora, fauna, and microorganisms within these environments need be considered. The introduction or examination of non-native species at potential sites of interest (i.e. release of specialized microbes) should not be considered.

Research areas may include, but are not limited to, the following:

- Identification of microorganisms with a potential bio-concentration of isotopes with short to moderate half lives that can be used to indicate the presence of recently detonated nuclear explosions. Potential pathways and biological half-lives of radio-isotopes within a broad range of environments (terrestrial and aqueous, tropical, desert, etc) should be identified and accounted for as well.
- Identification of micro- and macro-fauna with a potential bio-concentration of isotopes with short to moderate half lives that can be used to indicate the presence of recently detonated nuclear explosions. Potential pathways and biological half-lives of radio-isotopes within a broad range of environments (terrestrial and aqueous, tropical, desert, etc) should be identified and accounted for. Greater emphasis is placed on micro fauna as they are more likely to remain in close proximity to an area of interest though promising macro-fauna that are effective bio-accumulators are of interest as well.
- Identification of macro-flora with a potential bio-concentration of isotopes with short to moderate half lives that can be used to indicate the presence of recently detonated nuclear explosions. Potential pathways and biological half-lives of radio-isotopes within a broad range of environments (terrestrial and aqueous, tropical, desert, etc) should be identified and accounted for.

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***PerA-YIP-Topic 1: Sensing Fissile Material at Long Range using Novel Methods (Thrust Area 1)***

Young Investigator Awards for PerA-YIP-Topic 1 will average $100,000 per year.

For topic description, please see PerA-Topic 1.

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***PerA-YIP-Topic 2: Integration of Hyperspectral information to enhance Radiation Detection Modeling (Thrust Area 1)***

Young Investigator Awards for PerA-YIP-Topic 2 will average $100,000 per year.

For topic description, please see PerA-Topic 2.

***PerA-YIP-Topic 3: Ultra-low Level Detection of Nuclear Materials (Thrust Areas 1 and 5)***

Young Investigator Awards for PerA-YIP-Topic 3 will average $100,000 per year.

For topic description, please see PerA-Topic 3.

***PerA-YIP-Topic 4: Science of Advanced Silicon Compatible Technologies (Thrust Area 3)***

Young Investigator Awards for PerA-YIP-Topic 4 will average $100,000 per year.

For topic description, please see PerA-Topic 4.

***PerA-YIP-Topic 5: Science of Metamaterials for Radiation-Hardened Electronics, Acoustic and Photonic Functions (Thrust Area 3)***

Young Investigator Awards PerA-YIP-Topic 5 will average $100,000 per year.

For topic description, please see PerA-Topic 5.

***PerA-YIP-Topic 8: Meso-scale Diagnostics for Dynamic Events in Opaque Particulate Composites (Thrust Area 4)***

Young Investigator Awards for PerA-YIP-Topic 8 will average $100,000 per year.

For topic description, please see PerA-Topic 8.

***PerA-YIP-Topic 9: New Materials with Fast Energy Release using Novel Methods (Thrust Area 4)***

Young Investigator Awards for PerA-YIP-Topic 9 will average $100,000 per year.

For topic description, please see PerA-Topic 9.

***PerA-YIP-Topic 10: Radio-noble Gases and Chemical Fractionation (Thrust Area 5)***

Young Investigator Awards for PerA-YIP-Topic 10 will average $100,000 per year.

For topic description, please see PerA-Topic 10.

***PerA-YIP-Topic 11: Flora and Fauna as Screening Indicators for Underground Nuclear Tests (Thrust Area 5)***

Young Investigator Awards for PerA-YIP-Topic 11 will average $100,000 per year.

For topic description, please see PerA-Topic 11.

***PerA-YIP-Topic 12: Altering Antibody-Antigen Binding Kinetics (Thrust Area 3)***

Young Investigator Awards for PerA-YIP-Topic 12 will average $100,000 per year.

**Background:** Although efforts to develop improved diagnostic assays continue in earnest, immunoassay methods maintain "gold standard" status for both pathogen identification and seroepidemiology, primarily because of availability, relative ease-of-use, accuracy, and affordability. Immunologic methods have particular utility for assessing emerging diseases causally linked to infection by unknown pathogens. Unfortunately, existent immunoassay techniques are both time- and labor-intensive and, in their current form, are unlikely to be useful for rapid detection and diagnosis in a field setting. The development of a diagnostic platform that harnesses the accuracy of immunoassays for real-time detection would enhance biological monitoring capabilities and contribute to more effective prevention of disease outbreaks.

Performance efficiency of immunoassays is fundamentally related to antigen-antibody complex formation and detection of said complexes. Thus, several issues, including specificity, cross-reactivity, sensitivity, and signal detection, must be considered during assay development. However, with respect to optimizing an existent assay, the key parameters to be manipulated are reagent quality, reagent concentration, time, temperature, and kinetics. Although optimization of certain parameters (e.g., time and temperature) is relatively simple, optimization of others is complicated because changing the value of one parameter to optimize a single performance value (e.g., speed) may negatively impact another (e.g., sensitivity). As such, the application and performance requirements for the assay must be considered during the optimization process.

A significant rate-limiting step for immunodiagnostic assays is formation of the substrate-protein binding complexes. If reaction conditions could be altered such that the binding rate is maximized while still maintaining assay accuracy, then it may be possible to adapt immunoassays for use in real-time field deployable detection platforms. The present topic aims to develop fundamental knowledge related to the binding kinetics of antigen-antibody complex formation.

**Impact:** Investigating the kinetics that dictate antigen-antibody binding will ultimately enable the development of real-time diagnostic technologies that combine the desirable qualities of accuracy and efficiency. The proposed research is directly responsive to the objectives for promoting global health security, obtaining timely and accurate insight on possible disease risks, and advancing the field of microbial forensics as delineated in the National Strategy for Countering Biological Threats[10] (2009).

**Objectives:** The primary goal of the research described herein is to develop a better understanding of the means by which reaction conditions may be modified to alter antigen-antibody binding kinetics. The research focus is to evaluate binding kinetics. Applicants are urged to assess the methodology using a single antigen type.

Research areas may include but are not limited to the following:

- Using a standard immunoassay method for antigen detection, quantitatively assess binding kinetics for antigen-antibody binding complexes.

[10] National Strategy for Countering Biological Threats. 2009. National Security Council.

- Systematically alter reaction conditions such that (i) the functional integrity of the binding system is maintained and (ii) reaction kinetics are altered without compromising diagnostic accuracy.
- Develop a kinetics parameter map for the selected assay.

**JSTO-CBD Basic Research Needs**

***PerA-Topic 13: Understanding of Host-Pathogen Interactions for Burkholderia mallei, Burkholderia pseudomallei, Francisella tularensis, and Coxiella burnetii (Thrust Area 3-CB)***

Average Award Amounts for PerA-Topic 13:

- Single Scope Awards will average $250,000 per year.
- Multidisciplinary Awards will average $500,000 per year.

**Background:** Microbial agents use a variety of strategies to infect their host targets and cause disease. While a great deal of research has been dedicated to understanding pathogenesis, novel virulence mechanisms continue to be discovered, some of which may be targets for intervention. For example, Type VI Secretion Systems were just discovered in 2006, and since then have been found to impact the virulence of several gram negative bacteria including *Burkholderia pseudomallei* and *B. mallei*. However, it is also critical to understand host pathways involved in protection. Infections by these agents are often lethal or cytotoxic in experimental models, but cases in which the host (or host cell) survives have potential to offer critical information regarding the pathways by which natural host immune responses can prevent lethality.

**Impact:** This topic will support CBD Program goals by elucidating mechanisms by which intracellular bacterial pathogens and viral hemorrhagic fever viruses cause severe disease. It will also investigate host pathways that provide protection against these organisms. This knowledge has potential to feed the identification of microbial and/or host targets for medical countermeasures and diagnostic markers.

**Objectives:** The goals of this topic would be to: (1) investigate mechanisms by which *Burkholderia mallei, Burkholderia pseudomallei, Francisella tularensis,* and *Coxiella Burnetii* replicate and cause pathology and (2) elucidate mechanisms of protection against these organisms. Both theoretical and experimental models are of interest. Research under this topic must address both bacterial and host sides of the interactions and should address the following:

- Understanding of microbial factors impacting pathogenesis:
  - Molecular mechanisms of cellular invasion, intracellular replication/survival and cellular escape.
  - Molecular mechanisms of pathogenesis.
- Understanding of host factors impacting pathogenesis:
  - Molecular mechanisms of host-mediated pathology and/or protection.
  - Modulation of cellular signaling and immunological pathways.

- Theoretical models encompassing aspects of host-pathogen interactions on multiple scales.

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***PerA-Topic 14: Comparative Microbiology of Select Agent Viruses and Near Neighbors/Laboratory-Cultured Agents (Thrust Area 3-CB)***

Average Award Amounts for PerA-Topic 14:

- Single Scope Awards will average $250,000 per year.
- Multidisciplinary Awards will average $500,000 per year.

**Background:** Recent research has generated massive amounts of genomic sequence data for highly pathogenic organisms. However, it is also important to understand highly pathogenic organisms in relation to closely-related low- or a-virulent species/strains as well as the link between genotype and phenotype. This is particularly important to understanding the emergence of infectious diseases. Similarly, growth of microorganisms under laboratory conditions has been shown to impact their evolution at both the genotypic and phenotypic levels. Fundamental questions of whether culturing and/or manipulation leaves behind predictable indicators and which methodologies would be best used to detect and identify these indicators remain. Advances in -omics technologies and bioinformatics have enhanced the ability of researchers to identify and study the effects of specific single nucleotide polymorphisms, recombination events and protein expression on the resulting phenotype.

**Impact:** This topic will support CBD Program goals by providing a fundamental understanding of the differences between fully virulent Select Agent viruses and closely related low-virulence/avirulent neighbors. Understanding the differences between Select Agents and near neighbors is critical to the ability of detection and diagnostic systems to identify pathogens as opposed to closely-related a-virulent species, as well as provide insight into their evolution. Understanding the mechanisms by which Select Agent viruses adapt to laboratory conditions may impact detection and diagnostic systems, but also has potential to support efforts in microbial forensics.

**Objectives:** The goals of this topic are to (1) use comparative approaches to understand the evolution of virulence from avirulent organisms (and vice versa) and (2) develop techniques to characterize signatures of genomic or antigenic alterations (e.g., as a result of genetic manipulation, culturing, or selection). White papers emphasizing data analysis in addition to data collection will have higher priority. Research under this topic will reach beyond one-dimensional –omics analysis and may include the following:

- Fundamental understanding of differences between fully virulent Select Agent viruses and low/a-virulent near neighbors.
  - Comparative genomics, transcriptomics, proteomics, etc.
  - Analysis of strain-to-strain variation.
  - Investigation of algorithms to predict virulence within a genus/species.
- Characterization of laboratory-grown and/or genetically altered viruses.
  - Mechanisms of adaptation to laboratory conditions.
  - Signatures of molecular scarring.

- Analysis of viral proteomes as a function of growth conditions.

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***PerA-Topic 15: Investigation of Factors Enabling Viral Evolution and Emergence (RNA viruses) (Thrust Area 3-CB)***

Average Award Amounts for PerA-Topic 15:

- Single Scope Awards will average $250,000 per year.
- Multidisciplinary Awards will average $500,000 per year.

**Background**: The majority of diseases currently emerging into the human population are caused by zoonotic pathogens. Viral pathogens are of particular interest due to their ability to evolve rapidly. In particular, RNA viruses undergo rapid evolution due to, in part, the fluidity of their genomes and the ability to co-opt other organisms' infrastructure. This evolution leads to modulation of virulence as well as host tropism.

Multiple mechanisms of genomic and phenotypic plasticity confer upon RNA viruses the ability to form novel pathogens: quasispecies evolve as a result of error prone RNA polymerases, non-segmented and segmented RNA viruses undergo homologous and heterologous RNA-RNA recombination during co-infection, and some segmented RNA viruses undergo reassortment. In addition, enveloped viruses incorporate both viral and host proteins into and within their envelope, thus presenting a different "face" to each new host. Selective pressures within vectors, reservoirs, and hosts may drive the emergence of viral zoonoses via these mechanisms.

**Impact:** This topic will support CBD Program goals by enhancing understanding of the mechanisms by which viruses evolve and emerge as diseases within the human population. The identification of common themes in viral evolution, specifically with regards to emerging zoonoses, has the potential to impact biosurveillance of viruses and may enable prediction of impending emergence in areas to which U.S. troops have deployed. In addition, this knowledge may enhance the development of countermeasures against emerging infectious agents.

**Objectives:** This topic seeks to explore the mechanisms by which viruses modulate virulence and host tropism, thus emerging into new hosts. Emphasis is placed on RNA viruses (particularly the filo-, alpha-, bunya-, arena-, flavi-, and paramyxoviruses). Proposals to study the orthomyxoviridiae or influenza will not be considered. White papers emphasizing data analysis in addition to data collection will have higher priority. Topics of research may include but are not limited to:

- Influence of the viral envelope proteome on virulence modulation and host tropism.
- The role of protein recruitment into host membrane lipid rafts in viral budding and, ultimately, virulence and tropism.
- Role of RNA-RNA recombination to modulate host tropism and/or the emergence of a novel pathogen.
- Influence of selective pressures in disease vectors and/or reservoirs on the emergence and re-emergence of pathogens.

***PerA-Topic 16: Immune response mechanisms to organophosphorous agents and/or organophosphate pesticides (Thrust Area 3-CB)***

Average Award Amounts for PerA-Topic 16:

- Single Scope Awards will average $250,000 per year.
- Multidisciplinary Awards will average $500,000 per year.

**Background:** Prophylactic pretreatments against organophosphorous agents and/or organophosphate pesticides based on immune response have not been aggressively investigated, yet vaccines have been utilized to prevent/protect against illnesses caused by a wide variety of biological agents worldwide.

**Impact:** This topic will support CBD goals by providing fundamental knowledge as to how: (1) immune response can provide protection against organophosphates; (2) hHow chemicals could be conjugated to proteins in order to elicit a chemical-specific immune response; or (3) regulation of specific pathways that lead to organophosphate poisoning mitigation. Research in this area would shed light on the possibility of generating prophylactic pretreatments for organophosphorous agents and/or organophosphate pesticides.

**Objectives:** The goal of this topic is to investigate immunological and/or physiological responses that confer protection against organophosphorous agents and/or organophosphate pesticides. Research will include:

- Analysis of chemical-protein conjugates that induce chemical-specific antibody responses.
- Protective mechanisms conferred by chemical-specific antibodies.
- Identification/regulation of cellular pathways affecting physiological response to organophosphates.
- Demonstration/validation of mechanism(s) that confer protective organophosphate immunity or mitigate organophosphate toxicity.

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***PerA-Topic 17: Bio-inspired functional materials for CBD (Thrust Area 3-CB)***

Average Award Amounts for PerA-Topic 17:

- Single Scope Awards will average $250,000 per year.
- Multidisciplinary Awards will average $500,000 per year.

**Background**: Biomolecules (e.g., antibodies and enzymes) are used in many detection schemes (e.g., hand-held assays (HHA), enzyme-linked immunosorbent assay (ELISA), and polymerase chain reaction (PCR)). Their usefulness for broader CBD Program needs is complicated by their fragility, cost, and production. In addition, the scope of their utility is further restricted due to their compatibility with certain reaction media, their specificity, and/or their efficacy. The alternatives, such as optimizing the performance of biomolecules or development and production of efficient, rugged, and inexpensive synthetic substitutes are hindered by the lack of sufficient understanding of their functional mechanisms. Therefore, fundamental research undertakings are needed to enable the development of much cheaper and more robust biomaterials, as well as,

abiotic, and hybrid substitutes.

**Impact:** The research under this topic could: (1) enable the design and production of efficient, rugged, and inexpensive synthetic substitutes of biomolecules for chemical and biological warfare agent (CBWA) detection, decontamination, protection, prophylaxis, therapeutics, and medical diagnostics; (2) impact future technologies (e.g., lead to development of self-cleaning and functional surfaces for future systems) for other DoD and civilian applications; and (3) inform other sciences.

**Objectives:** The objective of this research topic is to advance the fundamental knowledge into the mechanisms of functionalities that would enable the design of bio-inspired rugged functional materials. The topic addresses the following: (1) understanding the mechanisms of the high efficiency phenomena of bio-systems; (2) using the acquired knowledge to design and construct more robust and efficient functional mimics; and (3) identifying new mechanisms that go beyond biomimetics for highly efficient synthetic substitutes. The ultimate goal is to develop reliable capabilities to predict functional efficiency of synthetic mimics and model highly efficient functional molecules. Research areas include:

- Designed biomaterials: understanding, design, and synthesis of more robust biomaterials with enhanced functionality.
  - Enzymes
  - Antibodies and receptors
  - Biomotors (actuation, locomotion, and energy production, storage, and utilization)
- Bio-inspired abiotics: biomimetics and beyond.
  - Enzyme mimics
  - Antibody and receptor mimics
  - Nucleic acid mimics
  - Nanomotors
  - Stimulus responsive nanostructures
  - Superhydrophobic and self-cleaning materials
  - Adhesive (e.g., gecko setae) or elastomeric materials
  - Biomimetic high-strength and ultra-lightweight materials
  - Biotemplated nanofabrication
  - Self-assembled, multifunctional, adaptive, self-repairing materials
- Hybrid functional nanomaterials: composites of abiotic and biomaterials.
  - Biomolecular and polymeric nanostructures

Highest consideration will be given to proposals that combine theory/heuristics and experimental verification with iterative (spiral) approaches to understand the underlying structure-activity relationships. The goal of this research topic is to provide improved fundamental understanding of functionalities in support of the development of a new generation of multifunctional materials that would allow the warfighter to address the challenges posed by the current and evolving CB

threats. Proposals offering the development of devices (e.g., sensors) will not be entertained.

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***PerA-Topic 18: Novel Materials Science for Filtration and Decontamination (Thrust Area 3-CB)***

Average Award Amounts for PerA-Topic 18:

- Single Scope Awards will average $250,000 per year.
- Multidisciplinary Awards will average $500,000 per year.

**Background**: There is a continuing need for improved protection, filtration, and decontamination of personnel and equipment against chemical and biological (CB) threats. Basic research in new materials with novel properties is necessary to provide the warfighter with enhanced capabilities to carry out missions in hazardous environments. The development of light, thin filter and barrier materials with self-detoxifying, selectively reactive, and highly sorbent properties will reduce the logistical burden for individual and collective protection and decontamination.

**Impact:** This topic will support CBD Program goals through new design, synthesis, and fundamental understanding of novel materials for improved protection, filtration, and decontamination of CB agents. Advances in materials science that allow for significant reduction in the weight of novel materials for protection filtration, and self-detoxification applications could alleviate the logistics burden for the warfighter. In addition, novel decontamination approaches that are more effective, and that require less power and reagents than the current state-of-the-art, will also significantly benefit the warfighter in the event of CB contamination.

**Objectives:** This topic seeks to expand fundamental research of next-generation materials for improved trapping and/or decontamination of CB threats. Proposed studies of newly discovered micro- or nano-structured materials that exhibit novel protective properties against CB threats will also be considered. Highest consideration will be given to innovative proposals that combine unique experimental approaches with theoretical modeling. Research areas include, but are not limited to:

- Fundamental investigation of the principles governing adsorption, absorption, and reactivity of molecules with porous nano-structured materials, yielding new concepts for advanced trapping and decontamination of CB threats.
- Materials that provide coupling of novel oxidation or other deactivation approaches with filtration and/or trapping of CB threats.
- Materials with controllable or switchable chemical impermeability, reactivity, and/or breathability (e.g., reactive membranes).
- Computational modeling of properties and reactivity of nano-structured materials to predict filtering, trapping, and/or decontamination capability.
- Novel, high-capacity sorbent materials that are not based on activated carbon.

***PerA-Topic 19: Basic Research in Nanofluidics (Thrust Area 3-CB)***

Average Award Amounts for PerA-Topic 19:

- Single Scope Awards will average $250,000 per year.
- Multidisciplinary Awards will average $500,000 per year.

**Background:** The miniaturization of sensors and devices with improved sensitivity for chemical and biological (CB) threat detection is important for reducing the logistics burden and enhancing the protection of the warfighter. The field of nanofluidics, which concerns the control and study of fluids in channel dimensions at the nanoscale (typically below 100 nm), is an emerging area of research. Much is still not known about the physical behavior of fluids when the physical length scales of the fluid, such as the Debye length or the electrical double layer, approach the dimensions of the confining nanostructure itself. Research into the physical phenomena governing the behavior of liquids, ions, and molecules in a nanofluidic environment will allow for improved fundamental understanding and harnessing of this field for further miniaturization of microsensors to the nanoscale.

**Impact:** This topic will support CBD Program goals by improving the fundamental understanding of fluidic behavior at the nanoscale. Due to the small volumes of liquids at this length scale, the miniaturization of channel dimensions to the nanoscale will be advantageous for the analysis of mass-limited samples. The separation of biomolecules and the application of electrochemical and/or optical detection methods are also fertile areas of exploration in this emerging field.

**Objectives:** This topic seeks to improve the understanding of nanofluidic fabrication, processes, and phenomena, which could lead to the development of field-deployable nanofluidic sensors for detection of CB agents. Basic research in the areas of chemistry, materials science, physics, biology, biochemistry, and computational science will be required to address the nanofluidic theoretical and technical challenges. Highest consideration will be given to proposals that are novel combinations of theory and modeling with experimental approaches. Research areas include, but are not limited to:

- Studies of new phenomena of heat and mass transfer at nanofluidic dimensions (e.g., fluid flow, diffusion, scaling effects, dynamic viscosities, fluidic slip length, and electrical double layer).
- Studies of nanofluidic-based transport and separation of molecules (e.g., ion depletion and enrichment, modified velocity and mobility, selective permeability, steric hindrance, entropy, adsorption, and hydrodynamic interaction).

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***PerA-Topic 20: Quantitative Modeling of Metabolic Networks of Intracellular Pathogens relevant to DoD (Thrust Area 3-CB)***

Average Award Amounts for PerA-Topic 20:

- Single Scope Awards will average $250,000 per year.
- Multidisciplinary Awards will average $500,000 per year.

**Background**: Survival of an intracellular pathogen depends on its ability to interact with host cells and function in an environment shaped by the host and modified by the pathogen. Understanding how the network of metabolic reactions of the pathogen interacts with the infected human host cell is a fundamental research question with broad implications. For example, understanding how changes in the chemistry of the host-cell environment affect key enzymes in the pathogen may provide insights about potential drug-targets that minimize human side effects. This problem is complex and has been chosen, in addition for its defense application, to expand the capabilities of bioinformatics, which is important to understanding many kinds of biological processes.

**Impact:** The research provided under this topic could provide insight about the interplay and feedback mechanisms between the metabolic network of host and pathogen, which is key for the development of countermeasures against intracellular pathogens.

**Objectives:** The research concentration areas of primary interest are in quantitative computer modeling of host-pathogen metabolic networks. The objectives of this research are to advance the basic science of host-pathogen interactions to: (1) advance the field of bioinformatics; (2) understand how the metabolic network of the pathogen affects and is affected by the host cell environment in a coupled *host-pathogen* network; and (3) understand how different metabolic enzyme activities are turned on/off during different stages of cell infection. The approach would be to develop computational models for specific host-cell environments applicable to macrophages and other immune cells, and then validate constructed models with known experimental data. Other areas of research that may impact this topic include, but are not limited to, the automated reconstruction of metabolic pathways under specific conditions, new mathematical models for multidimensional minimization, and enzyme kinetics and catalysis.

## Research Needs for Seed Awards

### ***PerA-Seed-Topic 21: Investigations of Synergistic and/or Antagonistic Polymicrobial Interactions (Exploratory/Developmental Research) (Thrust Area 3-CB)***

Average Award Amounts for PerA-Seed-Topic 21:

- Seed awards will be less than $75,000.

**Background:** Environmental microbiology has demonstrated multiple instances in which one microorganism substantially affects the growth or survival of another. In environmental mixed populations, microbes may secrete factors that either enhance or inhibit the growth of other species within the community. Furthermore, a limited number of pathogenesis studies have shown similar effects *in vivo*, either via direct interactions or host-mediated mechanisms. Investigations of polymicrobial interactions could shed light on novel mechanisms of inhibiting the growth of pathogenic organisms; however, the vast majority of microbiological studies involve a defined culture of a single organism. For this reason, exploratory research proposals to identify polymicrobial interactions that may be of interest for further studies are of interest.

**Impact:** This topic will support CBD Program goals by identifying interactions between microbes that impact the growth or survival of one another. This has potential to give insight as

to how to more efficiently culture fastidious organisms. Alternatively, research in this area could produce information regarding novel mechanisms by which the growth of pathogenic organisms could be inhibited.

**Objectives:** The goal of this topic is to encourage new, exploratory and developmental research projects by providing support for the early stages of project development regarding the identification of microbial interactions that impact growth and/or the course of disease of Select Agents. Research under this topic will include the following:

- Identification of *in vitro* polymicrobial competition that impacts Select Agent isolates.
- Discovery of polymicrobial competition in infection models.
- Identification of novel methods to culture fastidious, unculturable, and/or low abundance pathogens.